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Senate

COMPUTER PROBLEMS IN GOVERNMENT

Mr. RIBICOFF. Mr. President, the General Accounting Office, examining computer-related crimes in Federal programs, studied 69 individual cases that together totaled more than $2 million in losses to the Government.

The GAO inquiry revealed that computer fraud is a growing problem in both the Government and private sector and that, in many instances—no one knows how many—it is almost impossible to detect.

The name of the GAO study is "Computer-Related Crimes in Federal Programs." The study is dated April 29, 1976.

GAO obtained its information from the investigative files of the Criminal Investigations Division—CID—Command of the Army; the Navy Investigative Service—NIS—the Office of Special Investigations—OSI—of the Air Force; the Justice Department's Executive Office for U.S. Attorneys and the FBI; the Office of Investigation of the Agriculture Department; the Internal Revenue Service in Treasury; HEW's Social Security Administration; the Division of Investigation of the Interior Department; and the Investigation and Security Services of the Veterans Administration.

In the preponderance of the 69 cases, criminal prosecutions resulted.

GAO auditors cited these instances of computer crimes in Government:

A Defense Department fuel supply employee who had helped automate an accounting system introduced fraudulent payment vouchers into the system. The computer could not recognize that the transactions were fraudulent and issued checks payable to fictitious companies set up by the employee and his accomplices. These checks were sent directly to banks where the conspirators had opened accounts for the companies. The criminals then withdrew the funds from the accounts. Officials estimated the government paid this employee and his accomplices $100,000 for goods and that were never delivered.

A supervisory clerk responsible for entering claim transactions to a computer-based social welfare system found she could introduce fictitious food stamp claims on behalf of accomplices and they would receive the benefits. She processed more than $90,000 in claims before she was discovered through an anonymous tip.

An engineer who was no longer employed at a computer installation managed to continue using the equipment for his own purposes. Before he was discovered, he had used more than $4,000 worth of computer time. At another installation, a programmer used a self-initiated training program to obtain the use of his agency's computer system. But instead of working on the training exercise, he was developing his own computer programs which he hoped to sell, GAO auditors said.

The manager of a computer center processing personal information stole some of this data and sold it to private firms. The private firms, none of which were authorized to have such data, used the information to promote their products. GAO said that although the Government did not lose money in this case the privacy of individuals whose data records were involved was violated.

At one large Army installation officers estimated that 80 percent of all thefts may have been computer related.

In transmitting their report to the Congress, GAO auditors said they were precluded from being more specific about individual instances of computer fraud because first, in many instances information came from raw investigative files; second, several of the cases reviewed were still open or were about to be prosecuted at the time GAO completed its inquiry; and third, persons who had perpetrated computer frauds cooperated with GAO but with the understanding that they would not be identified.

GAO auditors said most of the cases they studied did not involve sophisticated attempts to use computer technology for fraudulent purposes. Instead, GAO said, these were uncomplicated acts which were made easier because management controls over the systems involved were inadequate.

Forty-three of the 69 cases of computer-related crimes were classified by GAO as being "fraudulent record initiation." Under this category, GAO included cases in which Federal employees, or

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persons employed by Government contractors, deliberately falsified information from records and documents to be fed into computers. Also included in this category was the act of falsifying claims by reuse of supporting documents previously processed.

The second category of computer-related crimes is termed "unauthorized or inappropriate use of facilities and supplies." This category includes developing salable programs on Government computers, doing commercial work for outsiders on Government computers and duplicating files and selling them.

"Processing alteration or destruction" is the third category of computer-related crimes studied by GAO. This offense includes such crimes as sabotage or altering information in the files affecting pay, promotion or assignment, and bypassing existing controls to enter unauthorized changes.

The final category examined by GAO is "misappropriation of output." Included under this section is the misappropriation of returned checks.

In connection with its review of computer-related crime in the Government, GAO commissioned the Stanford Research Institute—SRI—of Menlo Park, Calif., to study similar crimes in the private sector.

GAO said the SRI report indicates the same types of crimes occur in both the public and private sectors. GAO said in both the public and private areas the majority of crimes were committed by systems users—that is, persons working with the computers being abused—but the proportion of user crimes is larger in Government.

GAO auditors said the size of the average loss in private sector crimes is higher than in the Government cases studied. In a review of 144 cases, SRI found the average loss in private business to be $450,000. GAO said the average loss in those Government cases in which a dollar figure was apparent was $44,000.

GAO said the Government should improve its management controls over computers. GAO also pointed out that auditors of Government computer programs should be educated about the prevalence and types of computer crimes. GAO said that several Government computer auditors did not know about crimes which had been committed in their own programs until GAO informed them.

Another General Accounting Office study found that Navy auditors identified a computer as being incorrectly programed in 1969 but the computer was not fixed for 5 years, during which time the machine initiated unnecessary actions that cost the Navy $3 million a year.

GAO said one of the reasons the Navy gave for the 5-year delay was that Navy officials were concerned that by correcting the computer problem they might cause budget reductions.

Another instance of computer shortcomings, GAO said, could be seen in a situation in which Army computers directed the shipment of radioactive equipment without requiring the stipulated safeguards for proper handling.

These examples were cited by GAO to demonstrate problems in the Federal Government's "automated decisionmaking computers." These computers, operating without human supervision, annually initiate payments, purchases and other expenditures involving many billions of dollars in Government funds and resources and people are not required to review these actions to determine whether they are correct or not.

In its report, dated April 26, 1976, entitled "Improvements Needed in Managing Automated Decisionmaking by Computers Throughout the Federal Government," GAO concluded:

Computers in Federal departments and agencies annually issue unreviewed payments and other actions involving billions of dollars in government assets. These actions are often wrong. They can cost the government huge sums of money; exactly how much no one knows.

It is troubling to note the extent to which these decisionmaking computers are able to decide things on their own. Computer technology is progress, of course. But people should monitor closely what these machines are up to. For all their heralded memory banks and fantastic instant recall, computers are still basically beasts of burden. They have no intelligence, except for what information people insert in them.

"Automated decisionmaking by computers" occurs when computers are programmed to make payments, purchase material and otherwise spend money and take actions without the assistance of or review by people.

In their study of automated decisionmaking computers, GAO auditors concluded that these kinds of computers initiate more than 1.7 billion payments and other actions by government a year without any person evaluating whether they are correct.

Government automated decisionmaking computers issue each year a minimum of unerveiewed authorizations for payment or checks (excluding payroll) totaling $26 billion, the GAO report said.

Unreviewed bills totaling at lease $10 billion are issued annually by automated decisionmaking computers, the GAO auditors said.

In addition, the GAO said, these same computers issue annually unreviewed requisitions, shipping orders, repair schedules and property disposal orders for material valued at $8 billion.

GAO obtained information on 128 automated decisionmaking computer programs at the Army, Navy, Air Force, Defense Supply Agency, General Services Administration, Railroad Retirement Board, Veterans Administration and the Departments of Agriculture, Commerce, Housing and Urban Development, Interior, Treasury and Health, Education and Welfare.

The GAO auditors cited examples in which automated decisionmaking computers had resulted in millions of dollars of waste and, in one instance, the unauthorized handling

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of radioactive components for military equipment.

In 1969, the GAO report said, the Navy's own auditors found that a computer program serving the Navy Aviation Supply Office in Philadelphia was inadequately designed regarding the ability to correctly reflect demand for the purchase and repair of naval aircraft and spare parts.

The Aviation Supply Office in Philadelphia is the central manager for all the purchases and repair of aircraft and spare parts for the entire Navy. The Aviation Supply Office is under the Naval Supply Systems Command of the Department of the Navy.

The inadequacy in the automated decisionmaking computer program at the Aviation Supply Office was not corrected. The problem was noted in a GAO study issued May 21, 1974 entitled "Better Methods Needed For Cancelling Orders For Material No Longer Required."

Again, however, the inadequacy was not corrected and the decisionmaking computer continued to inaccurately reflect demand for new equipment and for repairs on naval aircraft. Five years went by before the needed correction was made. "At least $3 million in annual unnecessary costs were initiated by automated decisionmaking applications using this overstated demand data," GAO auditors said.

Design of the automated decisionmaking computers at the Aviation Supply Office was developed at the Fleet Materiel Support Command, Mechanicsburg, Pa., which also reports to the Naval Supply Systems Command in Washington.

GAO asked Navy officials why it had taken so long to correct the computer inadequacy. The GAO report said:

The reasons cited by Navy officials for the 5-year delay in initiating the modifications included:

Disagreements within the Navy on whether all canceled requisitions should result in reducing record demands,

High-priority workload at the design activity mandated by higher headquarters levels in both the Navy and the Department of Defense, and

Lack of pressure placed on the Navy command and design activity by the inventory control points since *reduced demands could result in budget reductions.* [Emphasis added.]

The Veterans' Administration—VA—uses automated decisionmaking computers to make monthly payments to more than 185,000 veterans in apprenticeship and other on-the-job training programs. The VA computers are supposed to be programed to make payments at a rate that decreases every 6 months, under the assumption that an individual veteran's pay from his employer will increase as he learns his trade.

Annually, the VA computers process about 1.4 million unreviewed checks for more than $225 million in apprenticeship and other on-the-job training benefits. However, the data submitted to the computers was incomplete and, GAO auditors said, checks went out at the highest levels to the veterans and no progressively declining payment system was implemented. The result, GAO said, was potential overpayments of $700,000.

Code 8 is the designation the Army gives to equipment and spare parts which have radioactive components and which, therefore, are required to be handled by authorized personnel in a stipulated manner.

GAO said it obtained from the Army Audit Agency data concerning the Army Electronics Command, Fort Monmouth, N.J., which processes each year at least 250,000 requisitions for material valued at a minimum of $250 million. About 35 percent of the requisitions are reviewed by people, GAO said, and the remaining 65 percent are processed by automated decisionmaking computers without review by people.

The Army Audit Agency examined 86 radioactive commodities handled by this Command's automated decisionmaking computers and found that 18 of the commodities were processed not with the radioactive designation of code 8—but instead carried a code 0 rating. Code 0 means that no special controls or handling are required, GAO said.

In addition, the GAO auditors said, another 11 radioactive commodities were categorized as code 1, the code that indicates that the item is scarce, costly or highly technical—but not that it is radioactive.

GAO said the Army Audit Agency also studied the application of automated decisionmaking computer technology at five Army inventory control points. The Army auditors found the computers were often in error in deciding where material should be shipped. The result, the Army auditors showed, was an annual loss of $900,000 in unnecessary transportation costs. In addition, a total of $1.3 million was incurred by the Army in the early 1970's due to unnecessary inventory increases caused by errors in these same computers.

The GAO report said that a major cause of inaccurate computer tabulations in the Government is the massive amounts of information fed into the machines which lead "input preparers"—that is, computer personnel—to make mistakes.

GAO noted, for example, that the Navy Aviation Supply Office in Philadelphia receives about 10 million "transaction reports" each year, all of which are then fed into computers. Transaction reports are mainly prepared by Navy facilities that receive, store and issue aeronautical equipment.

In addition, GAO auditors estimated that during a 12-month period the VA Center in Philadelphia prepared more than 4 million documents for insertion into computers.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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To insure more accurate automatic computer calculations, GAO proposed that the Government require selective or cyclical monitoring of actions directed by automated decisionmaking computers. The GAO also recommended that outside auditors or independent design teams from elsewhere in a given agency be called in to study the design of a computer program before it is allowed to begin making automated decisions.

A third General Accounting Office study found that the Federal Government's 9,000 computers which are involved in billions of dollars in transactions and contain vast amounts of information are inadequately protected against terrorism, vandalism, program alteration, and natural disasters.

We can see the potential harm in Government's failure to adequately protect computer facilities when we consider what enormous personal tragedies would result from serious damage to the social security computerized system. Social security could not function without its computers. It is impossible to estimate the effects on millions of our elderly citizens whose livelihood depends on social security should the computers be destroyed.

But the potential threat is not limited to social security. In terms of Federal revenues, for instance, imagine the havoc that would result from the destruction of Federal tax records.

In addition, the number of veterans in this country is larger than ever before. Each of these men and women who served in the Armed Forces may be receiving, or may be entitled to receive, benefits from their military service. Valuable data and records pertaining to their military service—and the benefits that accrue from that service—are on computer tapes and, in the event of catastrophe, could be lost forever.

Since 1965, responsibility for control of computer applications in the Federal Government has been shared by the General Services Administration, the Office of Management and Budget, and the Department of Commerce.

The GAO report is named "Managers Need To Provide Better Protection for Federal Automatic Data Processing Centers." It is dated May 10, 1976.

The GAO report said the total value of Government's 9,000 computers "is many billions" of dollars.

GAO said the value of some of the data which is processed on these computers such as social security records is immeasureable.

GAO auditors said:

Consequently—protecting equipment and data from unauthorized or inadvertent acts of destruction, alteration or misuse is a matter of inestimable importance,

GAO said, for example, that the National Aeronautics and Space Administration could not carry out space programs without computer applications; nor could the Federal Aviation Administration control aircraft effectively.

Computers are used to manage the more than half-billion transactions processed by the Social Security Administration and the 4 billion facts relating to the national population compiled and managed by the Bureau of the Census, GAO auditors said, adding that many other Federal agencies rely heavily on computer technology.

Catastrophic losses to Government-sponsored data processing installations such as the loss of human life, irreplaceable data and equipment have occurred, GAO said. In many of these losses, GAO said, additional security measures were implemented after the event.

GAO said information on the physical security measures employed at 28 Federal data processing facilities led its auditors to conclude that Federal data processing assets and valuable data are not properly protected.

GAO recommended that to provide more security over Government automatic data processing operations, the Office of Management and Budget—OMB—should direct that management officials be appointed at Federal installations having data processing systems and that they be assigned responsibility for automatic data processing physical security and risk management.

Reflective of the amount of money Federal agencies spend on computers, GAO said, is the fact that more than $10 billion is expended each year to buy and operate Federal data processing systems.

In concluding that security safeguards are inadequate regarding computers, GAO studied security techniques at 28 data processing installations of the Departments of the Army, Navy, Air Force, Agriculture, Transportation, State and Health, Education and Welfare and the Veterans' Administration.

Besides the 28 Federal data processing sites, GAO auditors also studied security problems identified at 23 additional Government computer installations.

In addition, GAO examined data processing security systems used at Government contractor sites, universities, private companies, a bank, and a local government.

GAO said major areas of security covered in its investigation of data processing facilities included steps taken by management to guard against threats of modification or destruction to the physical plant, personnel, computer hardware and software, and to the data being processed or stored by the computerized systems.

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Eighteen of the 28 data processing installations were in the continental United States. The remaining 10 were abroad.

Among its findings that computer installations are not properly protected, GAO noted that—

Fourteen installations had combustible paper supplies or magnetic tape files which were stored in computer rooms which exposed systems to losses from fire.

Three installations had computers which were in use in areas where only portable fire extinguishers were available.

One installation's computers were in operation where no portable fire extinguishers were available.

Twelve installations had computers which were in use above raised flooring without periodically cleaning below such flooring, constituting a fire hazard.

Six installations had computers which were in operation where master electrical power shutdown controls were not easily accessible at exit points.

Ten installations had computers in operation in areas where overhead water or steam pipes—excluding sprinkler systems—existed with inadequate provision for drainage.

Two installations had computers which were used in basements below ground level, exposing systems to potential flooding conditions.

Seven installations allowed vendor service personnel near computer banks without supervision.

Five installations allowed in-house service personnel to move about without supervision in computer areas.

Three installations located computers in quarters that were vulnerable to vandals.

Five installations managed their computers in ways susceptible to theft or misuse. Remotely located computer systems were in operation without controls to detect improper or erroneous attempts to use computers or data files.

Fourteen installations lacked contingency planning. Computerized systems were in operation without formal contingency plans to insure continuity of operations if an event occurred that threatened security.

GAO studied instances in which major data processing facilities had been hit by terrorism, vandalism, fire or natural disaster.

GAO said attempts at sabotage of computer activities have been made by employees within data processing centers. GAO said four attempts had been made to sabotage computer operations at Wright-Patterson Air Force Base near Dayton, Ohio, during a 6-month period ending November 15, 1974, by using magnets, loosening wires on the computer mainframe and gouging equipment with a sharp tool.

On August 24, 1970, a bomb exploded outside the Sterling Hall Building at the University of Wisconsin. This building housed the Army Mathematics Research Center and other federally funded research activities. One employee was killed and three others were injured. The explosion damaged 25 buildings at the university and resulted in a total loss of $2.4 million for buildings and equipment. Computers at the Army Mathematics Research Center were damaged and some programing efforts and 20 years' accumulated data was destroyed. It has been estimated that this research data represented more than 1.3 million staff hours of effort. GAO calculated this effort to represent an investment of $16 million.

In May of 1972, a bomb exploded on the fourth floor of the Pentagon above the computer facility and caused extensive damage. The computer facility was flooded from broken water pipes and parts of it were inoperable for about 29 hours.

The computer center at the National Institutes of Health, Bethesda, Md., has experienced many computer system failures due to electrical power failures. GAO said officials of the computer center estimated that they lost a minimum of $500,000 annually from electrical power fluctuations. During a 15-week period, the NIH computer center experienced 6 major electrical power fluctuations which caused 15 computer system failures. These failures resulted in destruction of data for 375 batch processing jobs and for 2,250 remote terminal users. GAO said these power fluctuations caused replacement of electronics costing more than $94,000 in various components of the computer systems.

On June 24, 1972, water from the Susquehanna River flooded all of downtown Wilkes-Barre, Pa., and filled the basement of the post office building. Water continued rising until about 6 inches of it were on the computer room floor. About $7.5 million worth of Government computer equipment was located on raised flooring on the first floor. Had the water risen about an inch more it would have ruined virtually all of the computer equipment, GAO said.

GAO described a 1959 fire at the Pentagon which destroyed three complete computer systems valued at $6.5 million. The fire started in a vault containing stored paper and magnetic tape and spread throughout the computer center. When the first occurred employees were unable to reach the switch to turn off electrical power for the computer system. This created a hazardous situation for firefighting efforts.

GAO cited another example of catastrophic loss caused by fire to a Government facility, although computer records were not directly involved. In July

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of 1973, fire broke out in the Military Personnel Records Center in St. Louis, Mo. Sections of the building housing these records were not equipped with sprinkler systems, smoke detectors or fire walls. Although the fire did major damage to papers and not computerized records, GAO said, it nevertheless illustrated how devastating the loss of irreplaceable documents and records can be. GAO said that since such records are being put on computers more and more, the problem increasingly becomes a computer security problem.

GAO said the St. Louis records center has been the repository for about 52 million records on military personnel actions since 1912. The sixth floor, where the fire started, contained about 22 million military personnel files or jackets. About 16.8 million of these records were lost.

Of the St. Louis fire, GAO auditors said:

This installation's mission is to maintain these official government records and to respond to inquiries made by the Congress, other government agencies and the taxpayer. This mission will now be hampered for some time because the lost records—some of which may be irreplaceable—must be reconstructed to satisfy inquiries, which is a costly and time-consuming process.

While it is unreasonable to expect that there would be backup for every original record in the manual files, it is reasonable to assume that some sort of contingency planning should have been done to insure continuity of operations when a loss has occurred. Agency officials told us that a contingency plan was formulated after the fire happened.

GAO cited an instance at Kelly Air Force Base in San Antonio, Tex., in which someone altered a computer program that resulted in a $100,000 theft of Government money. Due to the computer alteration, the Air Force paid $100,000 to bogus companies for aircraft fuel never delivered. The bogus companies were established by a Government employee working at the base. The employee had indepth knowledge of the computerized fuel accounting system which he helped develop and install. An investigation was begun when a bank contacted the Air Force regarding suspicious banking transactions involving Government checks. The employee was arrested, convicted and sentenced to 10 years in prison.

Among the agency comments to the GAO report were these:

James T. Lynn, Director of the Office of Management and Budget, said the GAO report was correct in citing a "need for greater awareness of threats to physical security" in automated data processing. However, Lynn said OMB did not support GAO's recommendation that an official in each agency be assigned responsibility for computer security. Instead, Lynn said, the head of each agency should decide how computer safeguards should be provided and who should be in charge.

Terence E. McClany, Assistant Secretary of Defense, Comptroller, said of the GAO report that in general, "the importance of the subject, the general substance of the report, and the thrust of the recommendations are wholeheartedly endorsed * * *"

John D. Young, Assistant Secretary of HEW, Comptroller, said, We full concur with the recommendations contained in the report . . ."

William S. Heffelfinger, Assistant Secretary for Administration in the Department of Transportation, endorsed the GAO study.

The GAO report did not identify any of the specific installations where it discovered inadequate safeguards against computer damage. GAO auditors felt that to identify these sites would be to run the risk that persons might wish to exploit these security weaknesses.

Mr. President, as chairman of the Senate Committee on Government Operations, I have directed the staff to conduct a preliminary inquiry into the problems associated with computer-related crimes in Federal programs, automated decisionmaking computers in Federal programs and computer security in Federal programs.

Also in connection with computer problems in the Federal Government, Rebecca Leet in the Washington Star of May 10, 1976 has written an informative article. Printed on page 1 of the Star, the headline of the article is "Two GAO Studies Criticize Lack of Controls on Computers." Mr. President, I ask unanimous consent that the Washington Star article by Ms. Leet be printed in the RECORD.

There being no objection, the article was ordered to be printed in the RECORD, as follows:

TWO GAO STUDIES CRITICIZE LACK OF CONTROLS ON COMPUTERS

(By Rebecca Leet)

The rapid movement of the federal government to greater and greater reliance on computers has not been accompanied by controls to assure that computer orders are appropriate or necessary, according to two General Accounting Office reports.

The result is a government highly susceptible to being defrauded, even by unsophisticated workers and to losing millions of dollars annually in overpayments, unnecessary repairs and the like.

Probably every federal agency which uses computers lacks the controls necessary to prevent the kind of computer fraud and mistakes which led to the $622 million overpayment in federal welfare benefits the Social Security Administration has made since 1974.

The Washington Star reported on Friday that audits by the Department of Health, Education, and Welfare had found that lax management of the Social Security computer system left large amounts of money exposed to errors and fraud.

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The GAO investigations, initiated by the agency after numerous reports of computer fraud in private industry, are the first time the federal government has looked at what steps it has taken to protect itself against computer fraud and mistakes since the government began using them in 1952. Currently, 9,000 computers are used by the federal government.

What GAO found, in most cases, is that government agencies have been more concerned with getting a computer program under way by the date promised than they have in seeing it function properly, according to the reports.

Ken Pollock, a GAO official who deals with computer policy, said the agency was "appalled" by the lack of controls it found. "In the old manual systems, everyone was very conscious of controls. . . . In the hurry to get automated, these things were ignored," he said.

The report on computer fraud noted that the control weaknesses which criminals were taking advantage of "are mostly basic management controls long recognized as being necessary to insure proper operations."

The rush to get the Social Security Administration's Supplemental Security Income (SSI) program instituted by its target date of Jan. 1, 1974, has been given as the main reason why the program has so many bugs in it. The Star previously disclosed that $622 has been overpaid the country's aged, blind and disabled welfare recepients under SSI.

Once a government computer system is in operation, Pollock noted, "there's always something else (for programmers) to do other than go back" and review the system to see if it is functioning properly.

Pollock said that GAO had difficulty in making its two studies because fraud by computers had never before been isolated from regular fraud and because no one had ever isolated the process which GAO called "automated decision-making by computers."

Automated decisionmaking by computers occurs when a computer is programmed to issue checks or bills or orders for an agency under certain circumstances and the actions are taken without humans ever reviewing them to see if they are correct.

GAO discovered that such computer programs annually issue payments or checks—excluding payrolls—totaling $26 billion. They issue bills totaling $10 billion and issue requisitions, shipping orders, repairs and disposal orders for materials valued at $8 billion. Humans never review any of those actions.

GAO said that while it believes most of automatic decisions the computers are correct, "we know from audit reports we reviewed that they also make bad decisions that cost the government many millions of dollars annually. Additionally, bad decisions . . . may result in harm to people."

"There is no federal-wide policy, guidance or other instructions on how computers issuing unreviewed actions should be managed by federal agencies," the report said. "There is little checking or monitoring of output on an ongoing or short-term periodic basis.

"Internal audit reviews of these computer actions are made sporadically or not at all," the report said.

Examples of the mistakes of such automated decision-making by computers, as noted in the GAO report, include:

The Navy yearly spent $3 million to perform unnecessary airplane overhauls from 1969 to 1974 because incorrect information was fed into the computer about the frequency of use of the airplanes.

(As the GAO report notes, once computer mistakes are discovered, they must be corrected to change the faulty outcome. The Navy resisted correcting this program error for two years after it was discovered at least partly, GAO was told, because it feared its budget would be reduced if a lower use level was shown.)

A faulty computer program led to the unneeded cross-country shipment of $1 million worth of Army supplies one year.

In a study of 89 such shipments, mistakes in a computer code resulted in 29 improper shipments of radioactive material. The material was shipped without proper safeguards and "there was doubt," the report noted, that customers in some cases should have received the material and in others that they knew it was radioactive.

Regarding computer fraud, the GAO said that contrary to the general assumption, those defrauding the government by computers are mainly the untrained, relatively unsophisticated computer users and not the highly trained computer programmers.

In 50 of 69 instances of computer fraud was committed by the computer user who knew which keys to press on a computer terminal to get a check issued to someone. Since no records are kept of computer fraud separate from regular fraud, the 69 instances which the GAO investigated, Pollock said, were all cases which government investigators recalled as having involved computers.

These instances, which occurred since 1970, resulted in the federal government being bilked out of $2 million. It was relatively easy to accomplish, GAO found, because of inadequate controls over the computer systems.

Of the 69 cases, investigators reviewed 12 in depth. Their conclusions went largely unchallenged by the agencies which were victims of the fraud, according to the report.

"In every case we reviewed in detail, the incidents were directly traceable to weaknesses in the system controls . . . The primary reason weaknesses in system controls existed was that management failed to recognize the importance of controlling systems," the report said.

"Managers . . . primarily emphasized their systems operational; control was not emphasized."

"Computer criminals were typically not 'professional' criminals, but persons who encountered difficulties on a short-term basis and who commit their crimes to help them solve their problems. They experience great personal suffering when their acts are discovered. Therefore, a highly visible and active audit function could dissuade them from attempting crime," the report noted.

The instances of fraud included amounts ranging from $320 to $250,000. Some of the fraud was not in bilking the government of money but in using government computers to design programs which were then sold to commercial firms.

Conclusions of the GAO reports, which were sent to all government agencies using computers, are not binding on agencies.

However, agencies must inform Congress within 60 days what actions they have taken as a result of the reports' recommendations on implementing controls. It is then up to Congress to decide whether legislation is needed to correct the deficiencies noted.

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REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Improvements Needed In Managing Automated Decisionmaking By Computers Throughout The Federal Government

STATINTL

George — thought this might of interest also —

[redacted]

1/23/76

Computers in Federal departments and agencies annually issue unreviewed payments and other actions involving billions of dollars in Government assests. These actions are often wrong. They can cost the Government huge sums of money; exactly how much no one knows.

This report describes the ways computers issue unreviewed actions and the causes for incorrect actions. It suggests remedies to correct the situation Government-wide.

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER I

INTRODUCTION

Many early business applications on computers involved entering, manipulating, and summarizing data and generating reports. Most output produced by these computers was manually reviewed (1) for correctness and/or (2) to decide what actions should be taken on the basis of the output report.

As more complex computer processing developed, the applications became more innovative. Computers were assigned certain repetitive decisionmaking work which duplicated steps people had taken to do the job previously. The output of these computers is frequently not reviewed by people (that is, no manual review).

These types of applications have no established name. We are calling them automated decisionmaking applications.

AUTOMATED DECISIONMAKING APPLICATIONS

Automated decisionmaking applications are computer programs that initiate action (though output) on the basis of programable decisionmaking criteria established by management and incorporated in computer instruction. The distinguishing characteristic of these applications, as compared to other computer application programs, is that many of the computer's actions take place without manual review and evaluation.

An inventory application is an example of a computer application program. If the computer processing of a requisition for material reduces the onhand quantity below the reorder point and if the computer issues a purchase order without anyone reviewing the proposed procurement quantity, then the application is an automated decisionmaking application. Some of the computer output of these applications is reviewed. In the foregoing example, the application may call for manual reviews of quantitites on all purchase orders over $5,000, with all purchase orders under that amount being released without review.

We reviewed these applications because (1) billions of dollars are involved in the unreviewed actions that they initiate and (2) of indications that funds were being wasted because of incorrect actions.

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CHARACTERISTICS

One objective of using computers operating under automated decisionmaking applications is to take advantage of their speed, accuracy, storage capabilities, and capacity to obey predetermined instructions. These applications are needed in part, because of the tremendous volumes of information to be obtained, manipulated (processed), analyzed, and acted on in carrying out agency missions and goals.

Automated decisionmaking applications process large volumes of transactions put into the computer system from various sources. They make repetitive decisions that, in many cases, previously have been made by people. The decision instuctions, built into the program, ask questions about the transactions and then initiate many actions through output. The actions depend solely on the criteria (logic) and data inside the computer system.

Computer program

The computer program (software), written by people, instructs the computer (1) to examine the input data and/or data already in automatic data processing (ADP) files, (2) to perform logical decisionmaking steps and computations in processing the data, and (3) to initiate actions in the form of output as a result of this process.

Input

Data is usually obtained by people from various sources and is put into the computer in machine-readable form (including punched cards, optical character recognition documents, paper tape, magnetic ink character recognition documents, and direct keyboard entry). The data can be entered directly for processing or can be recorded on ADP files for processing at a later time.

Output

The application outputs are such things as (1) directives to act (such as orders to ship material), (2) payment authorizations or checks, (3) bills, and (4) notices. A large percentage of the output of these applications is not manually reviewed and evaluated by people.

The following illustration shows a computer operating under automated decisionmaking applications.

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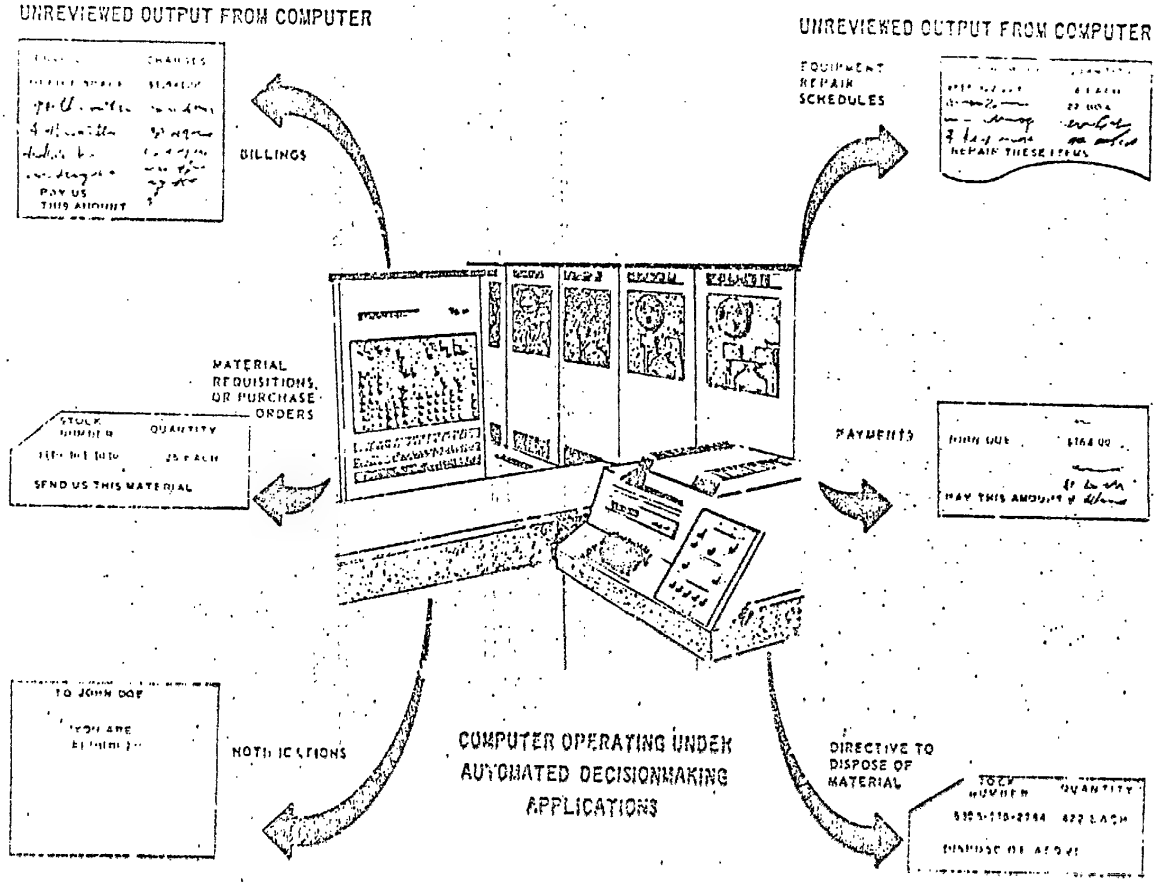

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The form of output varies (including listings, magnetic tapes, preprinted forms, and punched cards). These outputs indicate the decisions resulting from computer processing directed by the software.

The outputs that are not reviewed or evaluated are usually issued to the organizations and people which take the action being directed or which are being paid, billed, or notified.

Some of the output of many automated decisionmaking applications is manually reviewed. Under "management by exception" principles, some output, the nature and extent of which is determined by management, is sent to people in the organization for manual review and evaluation. This technique allows people to consider criteria, factors, and information not contained in the computer system in deciding whether the computer-directed action should be taken. For these applications manual intervention takes place only for the actions output for review.

The criteria for directing manual review of the output are contained in the decisionmaking part of the program. In the inventory application example, the program would direct that purchases over $5,000 be output for manual review. The applications can be programed so that none of the output will be manually reviewed or evaluated before actions are taken.

CONTRAST WITH OTHER COMPUTER APPLICATIONS

Application programs designed to provide output to people for information and analysis are not automated decisionmaking applications. Many types of these application programs are used in Government, and the outputs are sent to people for review before actions are taken.

Typical application programs that are not automated decisionmaking applications include:

--Systems that make recommendations, all of which are manually reviewed before actions are taken.

--Management and other information systems which provide data to various levels of managers to assist them in making policy, management, and operating decisions.

--Most mathematical models.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Improvements Needed In Managing Automated Decisionmaking By Computers Throughout The Federal Government

Computers in Federal departments and agencies annually issue unreviewed payments and other actions involving billions of dollars in Government assets. These actions are often wrong. They can cost the Government huge sums of money; exactly how much no one knows.

This report describes the ways computers issue unreviewed actions and the causes for incorrect actions. It suggests remedies to correct the situation Government-wide.

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FGMSD-76-5

APRIL 23, 1976

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-115369

To the President of the Senate and the
Speaker of the House of Representatives

Many Federal agencies use computers to initiate actions that are not reviewed by people. This report describes the many problems that have been experienced by agencies that use computers this way and offers some suggestions on how to solve them.

We made our study pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Commerce; the Administrator of General Services; and the heads of Federal departments and independent agencies.

Comptroller General
of the United States

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Contents

		Page
DIGEST		i
CHAPTER		
1	INTRODUCTION	1
	Automated decisionmaking applications	1
	Characteristics	2
	Contrast with other computer applications	4
2	USE OF AUTOMATED DECISIONMAKING APPLICATIONS BY FEDERAL AGENCIES	5
	Information about automated decisionmaking applications used by Federal agencies	5
	Functions supported by automated decisionmaking applications	6
	Number of automated decisionmaking applications and their impact on Federal agencies	6
	Reasons for output of actions for manual review and evaluation	8
	An example of what automated decisionmaking applications do	8
3	AUTOMATED DECISIONMAKING APPLICATIONS CAN MAKE BAD DECISIONS	10
	Conditions leading to bad decisions	10
	Software problems reported	13
	Data problems reported	16
	Internal audits of automated decisionmaking applications	18
4	CAUSES OF BAD AUTOMATED DECISIONS	20
	Software problems	20
	Data problems	27
5	FEDERAL MANAGEMENT OF AUTOMATED DECISIONMAKING APPLICATIONS	33
	Responsibilities for ADP management in the Government	33
	Policy actions by Federal agencies to manage automated decisionmaking applications	34
	What agencies do	35
6	AUTOMATED DECISIONMAKING APPLICATIONS CONTINUE TO MAKE BAD DECISIONS UNTIL PROBLEMS ARE CORRECTED	44
	Error detection	44

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER		Page
	Error correction	44
	Agency procedures for timely correction of software design problems	45
7	OPINIONS ON WAYS TO PREVENT OR REDUCE THE IMPACT OF PROBLEMS IN AUTOMATED DECISIONMAKING APPLICATIONS	47
	Possible solutions--software problems	48
	Possible solutions--data problems	49
8	CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS	50
	Recommendations	52
	Agency comments	53
APPENDIX		
I	Letter dated November 17, 1975, from the Assistant Secretary of the Department of Health, Education, and Welfare	56
II	Letter dated November 28, 1975, from the Associate Deputy Administrator, Veterans Administration	62
III	Letter dated December 29, 1975, from the Acting Administrator of General Services	63
IV	Letter dated January 2, 1976, from the Assistant Secretary of Defense (Comptroller)	65
V	Internal audit reports on automated decisionmaking applications	68

ABBREVIATIONS

ADP	Automatic Data Processing
ASO	Aviation Supply Office
DSA	Defense Supply Agency
FMSO	Fleet Material Support Office
GAO	General Accounting Office
GSA	General Services Administration
HEW	Department of Health, Education, and Welfare
OMB	Office of Management and Budget
SSA	Social Security Administration
VA	Veterans Administration

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

IMPROVEMENTS NEEDED IN MANAGING AUTOMATED DECISIONMAKING BY COMPUTERS THROUGHOUT THE FEDERAL GOVERNMENT

D I G E S T

Federal agency computers cause more than 1.7 billion payments and other actions a year without anybody reviewing or evaluating whether they are correct. Many agencies use computers in this way. At a minimum, Government computers issue annually:

--Unreviewed authorizations for payments or checks (excluding payroll) totaling $26 billion.

--Unreviewed bills totaling $10 billion.

--Unreviewed requisitions, shipping orders, repair schedules, and disposal orders for material valued at $8 billion.

COMPUTERS CAN ISSUE INCORRECT ACTIONS

Computers are complex data processing machines which are indispensable to the day-to-day operations of most Federal agencies. They can process data quickly and are especially useful in business-type applications which involve repetitive processing of large volumes of data. However, computer actions are only as good as the computer programs (or software) that make the computers operate and the data within the system. Computers can cause incorrect actions if these factors are wrong. The result is overpayments and unnecessary or premature costs.

Some agencies' internal audit reports show that unreviewed incorrect actions have been issued by several Government computers, incurring overpayments and unnecessary or premature costs of tens of millions of dollars annually. For example:

--Computers of one military department incurred increased inventory pipeline and transportation costs of $2.2 million because of erroneous software. (See p. 13.)

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--One military agency's computer caused millions of dollars in unnecessary and/or premature overhaul of equipment because of software and data problems. (See p. 14.)

Computers issuing incorrect actions over an extended period of time increase the impact of overpayments, unnecessary costs, and so on. It is important to detect incorrect actions. It is equally important to correct them as early as possible.

In this report, software that instructs computers to issue unreviewed actions are being called automated decisionmaking applications.

CAUSES FOR INCORRECT COMPUTER ACTIONS

Incorrect computer actions occur because of software problems and/or data problems. The causes of these problems are numerous.

Software problems, for example, can be caused by inadequate communications between people involved in software development. (See pp. 20 to 27.)

Data problems, for example, can be caused by the use of input forms that are too complex. (See pp. 29 to 32.)

FEDERAL POLICY AND AGENCY MANAGEMENT

There is no Federal-wide policy, guidance, or other instructions on how computers issuing unreviewed actions should be managed by Federal agencies. There is little checking or monitoring of output on an ongoing or short-term periodic basis. Internal audit reviews of these computer actions are made sporadically or not at all.

Several things can be done that will disclose some of the problems before they occur and/or before computers make decisions that can cause incorrect actions for an extended period. These practices should be considered for Government-wide use. (See pp. 47 to 49.)

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

RECOMMENDATIONS

GAO believes that, since automated decision-making applications have not previously been recognized as a separate problem area requiring management attention and since millions of dollars are presently being wasted as the result of actions generated by such systems, the Office of Management and Budget should act immediately to improve the situation. Specifically, GAO recommends that the Director, Office of Management and Budget, in his oversight capacity, require that:

--Each agency determine whether any of its computer operations involve automated decisionmaking applications.

--The agencies review each operation to determine whether incorrect actions are being taken as a result of these applications. (Pending issuance of technical guidelines by the National Bureau of Standards for making such reviews, the agencies should examine enough automatically generated decisions to provide a basis for deciding whether incorrect decisions are occurring and, if so, should take the necessary steps to correct the situation causing the inaccurate decisions.)

--Before any new automated decisionmaking applications are initiated by an agency, the proper steps are taken to insure correct decisions. This would include, pending issuance of National Bureau of Standards guidelines, a carefully chosen combination of independent review of systems design, adequate testing before implementation, and periodic testing of decisions after implementation, as discussed in this report.

--Agencies make reports on the actions taken, and establish an appropriate mechanism for monitoring reports.

GAO recommends that, because the National Bureau of Standards has responsibilities for technical aspects of automatic data processing, the Secretary of Commerce direct the Bureau to issue technical guidelines for developing, using, technically evaluating,

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

documenting, and modifying these applications in the Federal Government. When issued, these guidelines should contain certain criteria for independent technical reviews and for monitoring of these applications to insure problems are detected and corrected promptly. The General Services Administration should incorporate the Bureau guidelines in its agency directives.

In addition, GAO recommends that:

--As the General Services Administration suggested, the Civil Service Commission develop and add to its automated data processing training curriculum courses in automated decisionmaking applications so that managers, technical personnel, and auditors will become better equipped to deal with them in an appropriate manner.

--Internal audit groups in agencies having automated decisionmaking applications participate actively in design, test, and reviews of such systems to carry out their responsibilities.

Finally, GAO suggests that the Joint Financial Management Improvement Program consider this area for ongoing attention.

GAO is sending copies of this report to all departments and independent agencies for their information, use, and guidance pending issuance of the Office of Management and Budget and the National Bureau of Standards material.

GAO received comments from several agencies. They agreed in principle to the need for increased management attention to automated decisionmaking applications. (See pp. 53 to 55.)

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER I

INTRODUCTION

Many early business applications on computers involved entering, manipulating, and summarizing data and generating reports. Most output produced by these computers was manually reviewed (1) for correctness and/or (2) to decide what actions should be taken on the basis of the output report.

As more complex computer processing developed, the applications became more innovative. Computers were assigned certain repetitive decisionmaking work which duplicated steps people had taken to do the job previously. The output of these computers is frequently not reviewed by people (that is, no manual review).

These types of applications have no established name. We are calling them automated decisionmaking applications.

AUTOMATED DECISIONMAKING APPLICATIONS

Automated decisionmaking applications are computer programs that initiate action (though output) on the basis of programable decisionmaking criteria established by management and incorporated in computer instruction. The distinguishing characteristic of these applications, as compared to other computer application programs, is that many of the computer's actions take place without manual review and evaluation.

An inventory application is an example of a computer application program. If the computer processing of a requisition for material reduces the onhand quantity below the reorder point and if the computer issues a purchase order without anyone reviewing the proposed procurement quantity, then the application is an automated decisionmaking application. Some of the computer output of these applications is reviewed. In the foregoing example, the application may call for manual reviews of quantitites on all purchase orders over $5,000, with all purchase orders under that amount being released without review.

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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One objective of using computers operating under automated decisionmaking applications is to take advantage of their speed, accuracy, storage capabilities, and capacity to obey predetermined instructions. These applications are needed in part, because of the tremendous volumes of information to be obtained, manipulated (processed), analyzed, and acted on in carrying out agency missions and goals.

Automated decisionmaking applications process large volumes of transactions put into the computer system from various sources. They make repetitive decisions that, in many cases, previously have been made by people. The decision instuctions, built into the program, ask questions about the transactions and then initiate many actions through output. The actions depend solely on the criteria (logic) and data inside the computer system.

Computer program

The computer program (software), written by people, instructs the computer (1) to examine the input data and/or data already in automatic data processing (ADP) files, (2) to perform logical decisionmaking steps and computations in processing the data, and (3) to initiate actions in the form of output as a result of this process.

Input

Data is usually obtained by people from various sources and is put into the computer in machine-readable form (including punched cards, optical character recognition documents, paper tape, magnetic ink character recognition documents, and direct keyboard entry). The data can be entered directly for processing or can be recorded on ADP files for processing at a later time.

Output

The application outputs are such things as (1) directives to act (such as orders to ship material), (2) payment authorizations or checks, (3) bills, and (4) notices. A large percentage of the output of these applications is not manually reviewed and evaluated by people.

The following illustration shows a computer operating under automated decisionmaking applications.

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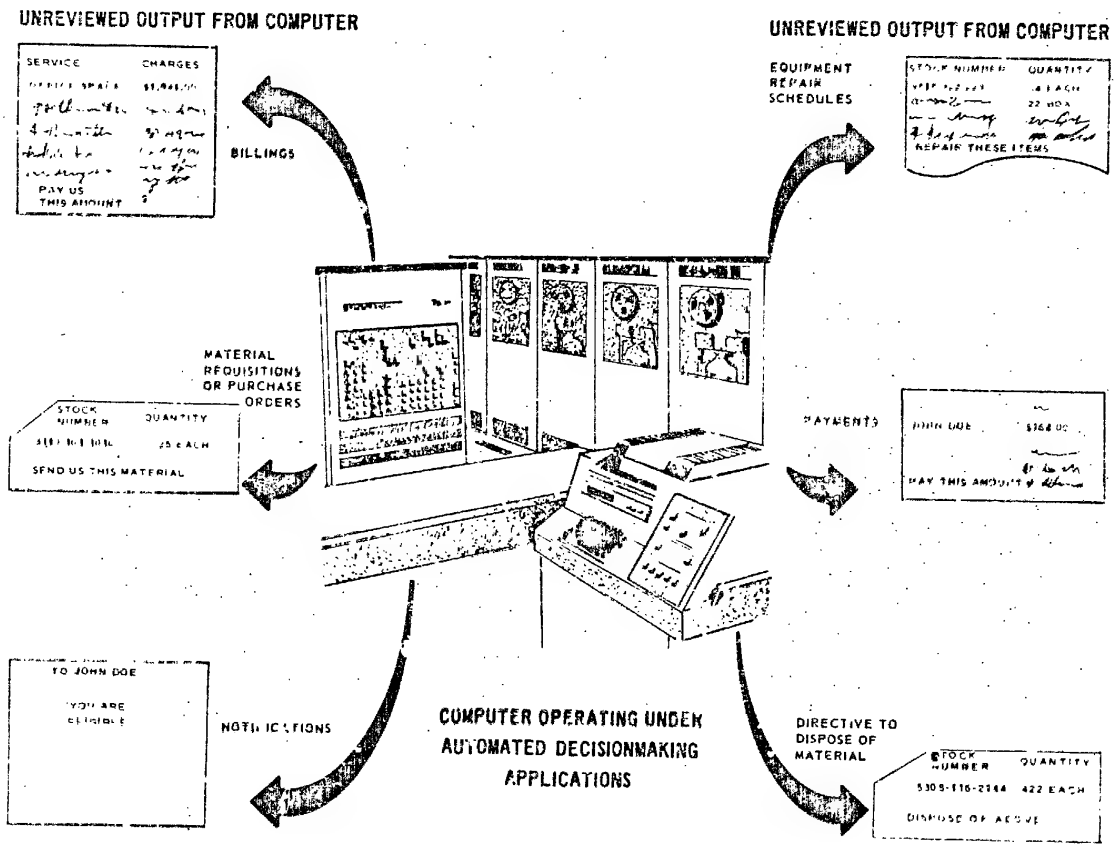

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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CONTRAST WITH OTHER COMPUTER APPLICATIONS

Application programs designed to provide output to people for information and analysis are not automated decisionmaking applications. Many types of these application programs are used in Government, and the outputs are sent to people for review before actions are taken.

Typical application programs that are not automated decisionmaking applications include:

--Systems that make recommendations, all of which are manually reviewed before actions are taken.

--Management and other information systems which provide data to various levels of managers to assist them in making policy, management, and operating decisions.

--Most mathematical models.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 2

USE OF AUTOMATED DECISIONMAKING APPLICATIONS BY FEDERAL AGENCIES

Many Federal agencies use automated decisionmaking applications to support their functions. Annually, more than a billion actions, involving billions of dollars, in directives to act, to make payments, to issue orders for material, and to bill for amounts owed are initiated. They also issue millions of notifications to people outside the Government.

INFORMATION ABOUT AUTOMATED DECISIONMAKING APPLICATIONS USED BY FEDERAL AGENCIES

We wanted to learn how these applications were used and to obtain data on their characteristics and monetary impact on Federal operations, but we found no central inventory. We therefore developed a questionnaire to gather information about Federal automated decisionmaking applications and distributed it to 15 agencies that use computers extensively. The information we wanted included:

--Functions supported by these applications.

--Numbers of these applications and their impact on operations (including output produced and annual volume and monetary impact).

--Whether certain parts of the decisions were being manually reviewed.

We obtained more detailed information about selected automated decisionmaking applications to understand and illustrate typical uses.

Almost all the agencies we contacted gave us examples of their automated decisionmaking applications. The information is summarized below.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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Defense departments and agencies	Number of examples	Civil departments and agencies	Number of examples
Air Force	14	Agriculture	6
Army	14	Commerce	4
Defense Supply Agency	9	General Services Administration	5
Navy	18	Health, Education, and Welfare	8
		Housing and Urban Development	6
		Interior	10
		Transportation	18
		Treasury	4
		Railroad Retirement Board	3
		Veterans Administration	9
Total	55		73

Total number of examples obtained--128

FUNCTIONS SUPPORTED BY AUTOMATED DECISIONMAKING APPLICATIONS

The questionnaires showed that automated decisionmaking applications supported many functions. A compilation of responses is presented below.

Function	Number of times function was cited	Function	Number of times function was cited
Controlling	48	Maintenance	30
Notification	48	Procurement	30
Fiscal	46	Diagnostic	23
Payment	46	Scheduling	20
Supply	44	Disposal	17
Billing	41	Cataloging	13
Distribution	38	Personnel	11
Eligibility	31	Safety	9

NUMBER OF AUTOMATED DECISIONMAKING APPLICATIONS AND THEIR IMPACT ON FEDERAL AGENCIES

No one collects statistics on these applications for the Federal Government as a whole, so we could not determine

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

the total number. Some of the agencies responding to our questionnaire said their responses consisted of representative applications. Therefore, our report about automated decisionmaking applications and their impact represents only a part of the Federal-wide total.

The responses identified 128 applications which issued several different types of unreviewed output. The nature of the output and its estimated annual impact on Federal operations, both in volumes and dollars, are summarized below.

Nature of output	Number cited	Total actions (000 omitted)	Total monetary impact (000,000 omitted)
Payment authorizations or checks to:			
Contractors or grantees	10	8,700	$ 7,221
Members of the public	23	715,000	18,589
Government employees (other than payroll)	3	200	8
Bills sent to:			
Contractors	3	100	15
Government organizations	17	17,300	6,549
Members of the public	18	19,100	3,298
Purchase orders or supply requisitions	24	28,000	4,456
Directives to ship material	22	260,200	a/2,500
Directives to dispose of material	11	8,000	a/56
Production, repair, or rework schedules or instructions	12	191,300	a/1,150
Notifications to members of the public	21	22,200	N/A
Other	48	447,300	N/A
Total	212	1,717,400	

a/Represents the value of material on which these actions were taken. Information collected indicates that the transportation costs represent about 5 percent of the value of material shipped; the disposal costs about 3 percent of the material disposed of; and production, repair, or rework cost about 23 percent of the value of the material.

The actions and monetary impact in the preceding schedule are for only a portion of the 212 output types. Many responses indicated that this data was not readily available. Our followup confirmed this.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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REASONS FOR OUTPUT OF ACTIONS FOR MANUAL REVIEW AND EVALUATION

Some of the applications initiate all actions without review. Most are designed, however, under the management-by-exception principle, which results in some of the output being reviewed by employees before the actions are implemented.

Several reasons given by agencies for reviewing some of the output are shown below.

	Times cited
Monetary value of indicated action exceeds prescribed dollar limitations	43
Criticality of the action to be taken	28
Eligibility factors related to the action	21
Geographic considerations of various types	11
Health and safety considerations related to the action	10

The percentage of actions initiated automatically varies from one application to another and can be adjusted by changing the processing criteria. The percentage of unreviewed actions identified by agencies participating in this study is shown below.

Percent of actions unreviewed	Number of applications
100	35
90 to 99	42
80 to 89	13
70 to 79	14
60 to 69	5
50 to 59	3
Below 50	14
No data provided	2
Total	128

AN EXAMPLE OF WHAT AUTOMATED DECISIONMAKING APPLICATIONS DO

Automated decisionmaking applications are designed to make internal decisions of varying degrees of complexity and to generate output containing the action to be taken. An example of one of these applications is shown in this section. Other examples are presented in chapter 3.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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Customer returns program

The Defense Supply Agency (DSA) uses an automated decisionmaking application--credit returns--to evaluate inquiries from military activities on what to do with surplus DSA-managed material. The options are to (1) return the material for credit, (2) return it without credit, or (3) dispose of it.

DSA's computers receive the requests in machine-readable form. The application identifies the commodity and refers to pertinent data about it from the ADP files (such as information on the quantities of the material already stored in DSA's inventory and expected future requirements). Using this and still other data, the application tells the activity what to do with the material. Usually these directives are sent without manual review.

During a recent 1-year period, two of the six DSA supply centers issued the following unreviewed directives using this application.

Nature of directives	Estimated volumes of unreviewed directives issued	
	Number of directives	Value of material
Ship the material (with or without credit) to the DSA supply system	174,000	$ 76,000,000
Dispose of the material	62,000	24,000,000
Total unreviewed advices	236,000	$100,000,000

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 3

AUTOMATED DECISIONMAKING APPLICATIONS CAN MAKE BAD DECISIONS

Whether actions initiated automatically by the computer are correct or not largely depends on (1) the internal logic of the program and (2) the data that is fed into the system.

Computers will produce bad decisions (1) if programers and analysts make misjudgments or errors in establishing the decisionmaking criteria or (2) if the application is not designed and/or coded in a manner that properly implements the decisionmaking criteria. Changing circumstances can make adequate decisionmaking criteria in the software obsolete, and bad decisions will occur if the software is not changed. Failure to design appropriate checks on input data, such as edit checks, can contribute to bad decisions. These applications can also make bad decisions if the data supplied to them is incomplete or incorrect or if the data is not obtained or processed quickly.

Some internal audit groups have reported on bad decisions made by Government automated decisionmaking applications. The computer-inititated actions caused the agencies to incur tens of millions of dollars of unnecessary costs, premature costs, and overpayments.

Such bad decisions may also harm individuals and impair an agency's ability to carry out its mission effectively.

CONDITIONS LEADING TO BAD DECISIONS

Adverse conditions common to several agencies have been reported. These conditions, resulting in the applications automatically initiating uneconomical or otherwise incorrect actions, can be broadly categoried as (1) software problems and (2) data problems.

Software problems

Several software problems that can cause bad decisions by automated decisionmaking applications include:

--Designing software with incomplete or erroneous decisionmaking criteria. Actions have been incorrect because the decisionmaking logic omitted factors which should have been included. In other cases decisionmaking criteria included in the software were inappropriate, either at the time of design or later, because of changed circumstances.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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--Failing to program the software as intended by the customer (user) or designer, resulting in logic errors often referred to as programing errors.

--Omitting needed edit checks for determining completeness of input data. Critical data elements have been left blank on many input documents, and because no checks were included, the applications processed the transaction with incomplete data.

Data problems

Input data quality is frequently a problem. Since much of this data is an integral part of the decisionmaking process, its poor quality can adversely affect the computer-directed actions. Problems include:

--Incomplete data used by automated decisionmaking applications. Some input documents prepared by people omitted entries in data elements which were critical to the application but which were processed anyway. The documents were not rejected when incomplete data was being used. In other instances data which the application needed and which should have become part of ADP files was not put into the system.

--Incorrect data used in automated decisionmaking application processing. People have often unintentionally introduced incorrect data into the ADP system. This incorrect data affected application decisions.

--Obsolete data used in automated decisionmaking application processing. Data in the ADP files became obsolete due to new circumstances. The new data may have been available but was not put into the computer.

Conditions that have been reported by internal audit

Unfavorable conditions were identfied by 32 internal audit reports of 7 agencies. These reports, issued during a 23-month period, demonstrated that the same conditions occurred in different agencies and were therefore common problems. The audit reports, however, did not show the total occurrences and dollar impact of these conditions, past or present, in federal automated decisionmaking applications.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

The results of our analysis of these audit reports are summarized in the following table. (For further details, see app. V.)

Category and condition	Number of agencies	Number of internal audit reports	Number of times condition was reported (note a)
Software problems:			
Incomplete, erroneous or obsolete decision-making criteria	7	14	30
Programing errors	5	10	10
Criteria or programing (note b)	5	11	14
Absence of needed edit checks	4	5	11
Data problems:			
Data elements incomplete	6	10	16
Data elements incorrect	5	17	30
Data elements obsolete	3	3	3

a/Each condition can occur more than once. Software problems, such as programing errors, may have occurred in more than one portion of the program or the condition may have been observed at more than one location, each designing its own program. The data conditions were based on the number of different data elements that were either incomplete, incorrect, or obsolete at least once.

b/Internal audit reports were not sufficiently detailed to arrive at an opinion as to whether the problem was in criteria or programing.

Only 13 of the 32 reports had estimates of the monetary impact of bad decisions, but these estimates ran to tens of millions a year in unnecessary and premature costs and in potential overpayments. Some reports cited specific cases but provided no estimates of the total monetary impact. Other reports cited potential mission impairment and possible harm to individuals.

The following sections are based on internal audit reports selected from the 32 reports obtained.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

SOFTWARE PROBLEMS REPORTED

Examples of software problems are presented to demonstrate the problems frequently experienced with automated decisionmaking. The examples are not intended to be a criticism of the agencies involved, because these problems can occur wherever these applications are used.

Army processing of requisitions for shipment to overseas locations

Several Army inventory control points provide material support to overseas customers which submit requisitions for materials to the control points. Automated decisionmaking applications are used to screen material availability at U.S. depots. The computer produces a directive which is automatically issued to a depot to ship material to the overseas customer. These applications process over 100,000 overseas requisitions annually.

Early in the 1970s the Army implemented a system designed to improve supply support to overseas customers from U.S. depots. The control points were instructed to design their ADP applications so that material would be issued from east coast depots to satisfy European customers and from west coast depots to satisfy Pacific customers. Controls were required to prevent the software from releasing cross-country shipments without manual review.

The Army Audit Agency examined the applications in effect at five control points. At four activities it found that the applications were not adequate to insure maximum filling of requisitions from the appropriate depots. For instance, in the initial requisition processing for overseas customers, the software used by one of the high-volume control points screened stock availbility at eight depots before finding the appropriate depot. For releasing back-ordered-stock requisitions, depots on the opposite coast were often selected for material availability. The auditors reported that, at three control points, controls to prevent the automatic release of material from the wrong depots were not implemented and material was automatically released for cross-country shipments. At least two control points used software that existed before the criteria for supporting overseas activities were developed.

The audit agency estimated that, because of the use of this erroneous criteria, unnecessary transportation costs of $900,000 a year were incurred. In addition, $1.3 million was incurred in increased inventory investment (pipeline) costs.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

The Army Materiel Command agreed with the audit agency's assessment of the problem and promised to revise the criteria contained in Army control point applications.

Navy scheduling of aircraft equipment for overhaul

The Navy's central manager for aircraft spare equipment and parts uses a computer to identify and schedule overhaul for reparable components needed for future use. Until April 1974 the application used was called the Navy integrated comprehensive reparable item scheduling program. 1/

This application considered inventory on hand, requirements, and other data in ADP files to determine

--which components should be scheduled for overhaul,

--what quantities should be overhauled,

--which depots should do the work, and

--what priorities depots should give in deciding which items should be overhauled first.

Depots used punched card output as the basis for scheduling components for induction into their overhaul facilities. Priority levels shown on the output affected the depots' decisions regarding which items and quantities would be overhauled first. (Not all the quantities the program indicated for overhaul were processed because of limited depot overhaul capacity.)

The priority levels shown in the output ranged from level 0 (zero)--highest priority--to level 3--lowest priority.

During a 1-year period, 2/ Navy facilities spent about $145 million to overhaul aircraft components valued

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1/In April 1974 the Navy integrated comprehensive reparable item scheduling program was replaced by another automated decisionmaking application called cyclical repair management. We believe that the problems that occurred in the first program could affect cyclical repair management in a similar way, but GAO's review did not evaluate the new program.

2/The figures presented are for an overlapping but not identical period. The overlap is 6 months.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

at about $797 million--mostly on the basis of the program's output. The Naval Audit Service, reviewing the operation, identified several major software problems, all of which resulted in overstating overhaul requirements.

--A data element used in computing priority level 1 contained data that resulted in duplications in computing levels 2 and 3. Gross overhaul requirements scheduled by the program were therefore overstated. When the program was designed, this duplication was overlooked.

--Data elements showing recurring material usage, used to compute levels 2 and 3, were greatly overstated because of two software problems.

1. Required reductions to the material usage quantities were not made automatically, because certain Navy activities were leaving a data element blank on input documents sent to the central manager. Our followup determined that because of the designer's oversight or judgment error, no edit check was placed in the software to detect this missing data.

2. There were no software procedures for automatically reducing recorded material usage quantities when customers canceled back orders and requisitions. Our followup disclosed that when this application was designed, the designer believed that canceled back orders and requisitions would rarely occur.

The Naval Audit Service estimated the effect of these incorrect actions was millions of dollars in unnecessary and premature overhaul costs. Although the Navy Command officials did not agree with the auditor's reported figures, they agreed that the problems identified were valid. Corrective actions have been taken or initiated.

A GAO report (B-162152, May 21, 1974) "Better Methods Needed for Canceling Orders for Materiel No Longer Required" discussed the Navy's practice of not automatically reducing recorded material usage when unfilled customer orders were canceled. The report stated that "we estimate that this overstatement resulted in annual unnecessary materiel buys and repairs totaling about $10 million." Of that amount, more than $3 million was for repairs initiated by this automated decisionmaking application.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

DATA PROBLEMS REPORTED

The following examples of data problems show how bad data can adversely affect the actions directed by automated decisionmaking applications.

Veterans Administration payments for apprenticeship and other on-job training

The Veterans Administration (VA) uses a computer application to make monthly payments to more than 185,000 veterans in apprenticeship or other on-job training. This application is designed to make payments at a rate that decreases every 6 months, under the assumption that veteran's pay will increase as he learns his trade.

Data put into the computer is the basis for automatically determining the rates at which the veteran will be paid. Each month, additional data is put in regarding the veteran's continuing eligibility to receive the payments.

This application is programed to read input documents and distinguish apprenticeship and other on-job training awards from other types of education awards. When the application recognizes these on-job training awards, it refers to appropriate rate tables to determine the proper payment. The application refers to a new lower rate every 6 months and automatically initiates payments at the reduced rate. Annually, this application initiates about 1.4 million unreviewed checks for more than $225 million in apprenticeship and other on-job training awards.

Two types of input documents initiate payments for these awards. An original award document is designed to initiate payments to a veteran not previously receiving them. If the veteran has already received benefits and there is a need for (1) reentrance, (2) a supplemental award, or (3) new key data such as dependency changes, a different input document (supplemental award code sheet) is prepared. Both documents contain data elements that allow the computer to determine that it is an apprenticeship and other on-job training award and that the reducing rate table should be used.

The data entry on the supplemental award document that causes the program to build the scheduled rate reduction is code 77 in a data element called change reason.

VA internal auditors reported that 22 of 121 tested supplemental award documents for these benefits did not

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

contain change reason code 77 on the input documents (the data problem). These documents were received from 10 different VA locations. The application accepted and processed the documents because the software did not contain an edit check to disclose and reject documents with incomplete entries in this data element (a related software problem).

Because the data was incomplete, the computer used a single rate for the entire period of training at the highest step indicated. This problem caused potential overpayments of $700,000.

Possible causes cited for processing incomplete input documents included new personnel--requiring additional training--and fatigue. The designer overlooked the needed edit check, a software problem, in preparing the detailed and complex software.

Army processing requisitions for radioactive material

The Army uses a computer to automatically process customer requisitions for commodities. One Army agency uses an application to process at least 250,000 requisitions annually for material valued at a minimum of $250 million. About 35 percent of the customer requisitions are output for manual review and evaluation for any of several reasons. The remaining 65 percent are processed without manual review.

Some commodities the agency manages contain radioactive material. The Army master data ADP file is supposed to contain a special control code (code 8) in a specific data element for commodities containing radioactive material. This code, which should be put in by item managers, prevents automatic issues. The item managers receive commodity requisitions for review and evaluation. This manual intervention is required to insure that the requisitioners are (1) authorized to receive the material, (2) aware of the radioactive content, and (3) aware of the safeguards that must be used.

The Army Audit Agency reviewed 86 radioactive commodities which the agency managed to determine if the proper special control item codes were contained in ADP files. The review showed that 29 of the commodities were incorrectly coded.

--Eleven commodities were coded as a regulated item (code 1) but not as radioactive. (A regulated item is one that is scarce, costly, or highly technical.)

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--Eighteen commodities contained an O code in the ADP files. An O code indicates that no special controls or handling are required. Many requisitions for these commodities are processed automatically.

Most of the incorrectly coded commodities had been in the supply system 4 to 13 years.

During the Audit Agency's review of 1 year's transactions, at least 38 customer requisitions were automatically filled for 18 incorrectly coded commodities. Army customers and foreign governments under military assistance programs were issued 423 units on these 38 requisitions.

Since the commodities were incorrectly coded, the item managers did not coordinate the issue of the units with the 38 customers. Consequently, there was doubt that the customers should have been issued the material or that they were aware of the radioactivity in the commodities.

Army officials cited the following possible reasons for the incorrect codes contained in ADP files.

--The item managers who prepared the input to ADP files may not have been fully aware of the requirements and procedures for coding radioactive material.

--The agency's health physicist may not have notified the item managers of the radioactivity contained in these commodities.

--The item managers may have been notified but failed to input the correct data codes.

Army officials agreed with the Audit Agency's findings and said they would (1) correct the ADP files for all radioactive commodities, (2) reemphasize to item managers the need for assigning the proper special control item code to commodities, and (3) have a health physicist study the commodities to insure that the items could be used safely by the customers that received them automatically. The special study determined that the commodities involved could be safely used by the recipients.

INTERNAL AUDITS OF AUTOMATED DECISIONMAKING APPLICATIONS

Since published internal audit reports were the sources of our information on bad decisions, we asked nine internal

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

audit groups about the nature, approaches, and frequency of scheduling audits of these applications.

We learned that certain internal audit groups rarely became involved in the applications' logic because they lacked the expertise to effectively make such studies.

No internal audit group has prepared lists of agency automated decisionmaking applications and scheduled reviews of their decisions, either routinely or when the system is modified. However, several audit groups schedule specific agency functions for audit, and if the functions are supported by these applications, auditors will get involved in the internal decisionmaking logic to evaluate the agency's performance.

Agency functions are generally audited on a cyclical basis, but the cycle may be anywhere from 2 to 8 years. Ordinarily, the frequency of review is not dependent on whether the function is supported by an automated decisionmaking application. In addition, auditors may review functions and related automated decisionmaking if there is (1) a special request or (2) an indication of a problem based on complaints. On the basis of approaches taken by internal audit groups, it appears that many of these applications go unaudited for long periods of time or may never be audited.

Although many of the audit reports adequately show many of the common problems that exist, they do not show the overall impact of the problems for all automated decisionmaking applications. In fact, there is no basis for estimating the total impact of bad decisions currently being made by these applications.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 4

CAUSES OF BAD AUTOMATED DECISIONS

The two basic automated decisionmaking application problems, software and data, are often interdependent. For example, automated decisionmaking applications making bad decisions because of incomplete data elements on input documents illustrate both a data problem and a software problem because (1) input documents have not been properly prepared (data) and (2) edit checks for completeness have not been properly designed (software). Other problems, such as when incomplete or erroneous decisionmaking criteria are used (software) and incorrect data is put into the application (data), can occur independently.

The problems in each of these two areas are caused by a variety of factors. We identified many causes of these problems by (1) corresponding with people experienced in software design and data management, (2) discussing them with officials of selected Federal agencies, and (3) analyzing published internal audit reports.

SOFTWARE PROBLEMS

Computer programs are usually developed and modified by a combination of people: the user (or customer), that requires the computer assistance; the designer (or analyst), who translates the requirements of the user into a logical structure; and the programer, who translates the logic into program instructions which can be recognized and used by the computer.

The software development and modification process was similar at each Federal agency we visited. Variations are not related to the process itself but rather involve such factors as

--organizational setup and physical locations;

--titles of people performing various aspects of the work; and

--nature of the documentation that will be prepared, such as use of program flow charts.

Causes of software problems

Agency officials said that the design or modification and programing of software could not be guided by specific instructions on how best to do the work. Instead, agencies

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

rely on people who know (1) the function supported by the computer and (2) the art of design and coding so that the computer can perform the desired tasks. Some agencies provide broad guidelines on the process, the documents to be used in the process (documentation), and at one agency, instructions on what designers and programers should consider when doing the work.

The user initiating the work sets forth many of the specifics regarding the internal decisionmaking criteria to be used. Often the designer makes some decisions. Both act on the basis of their knowledge of the function, available guidelines in terms of management instruction or legislation, their perceptions of the transactions to be processed, and communications with each other. Sometimes they will call on operations research experts to help them design new criteria, while sometimes they will use existing criteria to process similar transactions.

The designer takes the established criteria and prepares more specific documentation which is used for programing. The design and programing documents developed become very detailed and complex, because the computer is instructed to operate in a logical step-by-step manner on a large number of different conditions. Even less complex applications can consist of thousands of individual instructions that must be designed and programed to do what the user and designer perceive to be correct.

The designer and user are usually responsible for designing edit checks into the program. This includes checks for the completeness of data elements on input documents. According to agency officials, edit checks are placed in the software for data that is critical to the decisionmaking, such as when incomplete or erroneous data can affect the determinations made by the computer. Some officials said that edit checks are placed for almost every data element. One agency is making an overt effort to limit edit checks to reduce the number of documents rejected by the computer.

In developing software, it is generally accepted that the lines of communication between the user and designer and the designer and programer must be effective.

To identify some of the causes for the software problems presented in chapter 3, we

--discussed them with Federal officials at several agencies;

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--received responses to questionnaires from 257 individuals who are experienced in the areas of ADP software design, modification, and programing; and

--analyzed causes cited by internal auditors.

A schedule summarizing some of the causes of software problems is followed by a discussion of each.

Summary of Causes of Software Problems

Cause	Opinions of people answering the questionnaire--degree of cause (note a) Moderate to very large	Somewhat small or none	Identified from contacts with officials of federal agencies (note b)	Cited as a cause by internal auditors
Inadequate communications between the parties to software design	251	4	x	
Incorrect perceptions of the nature of actual transactions to be processed	233	22	x	x
Inadequate documentation preventing adequate reviews of software	229	28	x	x
Time constraints hampering the effectiveness of the design process	216	40	x	
Absence of written criteria or guidelines for designers to follow	204	49	x	
Detail and complexity involved in designing, coding, and reviewing software	177	79	x	x
Reliance on the expertise and experience of people doing the work (state of the art)	171	83	x	x
Undetected changes in circumstances making the application obsolete	167	90	x	x
State of the art in software testing which prevents testing all possible conditions	164	91	x	

a/The questionnaire presented "some possible causes of the design conditions (problems) * * *," and asked that "based on your software design experience * * * indicate the degree to which you believe each of these causes contributes to the design condition (problems) in general." The responses allowed were to a: very large degree, somewhat large degree, moderate degree, somewhat small degree, very small degree, or not at all.

b/Our contacts were made with various organizational elements, excluding internal audit, within five agencies: Department of the Navy; Department of the Air Force; Department of Health, Education, and Welfare; Veterans Administration; and National Bureau of Standards.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

The problems identified are caused at various phases of the software design process including

--user determinations,

--designer actions, and

--program coding.

Many problems are not detected through the review and test phases of the process and are therefore continued through implementation and operation of the automated decisionmaking application. Officials at the National Bureau of Standards and the Air Force believe that it is impossible to insure the design of completely error-free software under the current state of the art.

Inadequate communication between the parties to software design

At least three groups of people must adequately communicate to develop or modify the applications successfully. Assuming that the user knows what he wants the computer to do and that his criteria are correct, inadequate communications of this information can result in developing software that is not exactly what the user wants.

Much has been written about the communication problem in software development, and it is generally recognized as a human problem.

Incorrect perceptions of the nature of actual transactions to be processed

Decisionmaking criteria used in these applications have sometimes been erroneous, because people developing them made wrong assumptions about the nature of the transactions that were to be processed. They may have relied on limited data about the transactions and established the criteria on their judgment.

Officials of one agency believed that a large percentage of automated decisionmaking application software problems were caused at the very beginning of the design process by people involved in defining requirements and establishing decisionmaking criteria.

In other cases, the designer may have used criteria contained in existing software to process transactions in a similar, but not identical, environment. Sometimes this is

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

done to shorten design and programing time, but it can and has caused problems.

Inadequate documentation preventing adequate reviews of software

In our October 8, 1974, report (B-115369) "Improvement Needed in Documenting Computer Systems," we noted that some agencies had not developed adequate guidelines for preparing good documentation. Several Federal officials said that this was still a problem and that documentation for many computer applications (including automated decision-making) was inadequate.

The report stated:

"In one case documentation explaining the objectives of the computer system was not prepared by the systems analyst. Without this information, management could not adequately monitor the system's development. * * * the system did not accomplish the results originally intended by management.

"In another case, inadequate documentation was cited as causing management to spend over a year to determine how the various programs in a complex system operated."

Adequate design documentation is needed to allow for

--reviewing the work done during application design and modification,

--making the necessary modification,

--correcting errors when they are detected, and

--insuring the application is operating as intended.

Time constraints hampering the effectiveness of the design process

Many systems containing these applications are designed or modified because of legislation or other high-priority requirements imposed by top management. Often this calls for implementation by a specific date. Developing and/or modifying software within the required time frames can hamper efforts to insure its adequacy. Agencies that must make changes to these applications on the basis of legislation include VA and the Department of Health,

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Education, and Welfare (HEW). The Department of Defense often must make software modifications based on high-priority requirements imposed by top management.

Absence of written criteria or guidelines for designers to follow

Federal officials had many opinions about the need for and nature of written guidelines that should be provided to designers of software. The agencies we visited had varying degrees of formal guidelines, but none provided instructions on how to do design work.

Some officials who believe that written criteria and guidelines on how to design software are not desirable refer to the process as an art that cannot be guided or improved by written instructions. However, the consensus of responses to our questionnaires indicates that the absence of criteria or guidelines can be a major cause for some automated decisionmaking application problems.

Detail and complexity involved in designing, coding, and reviewing software

Even smaller applications can be extremely complex and detailed when designing and coding the processing logic and edit checks. The complexities and detail involved may also hamper the review process that may exist.

An illustration of the problem is VA's automated decisionmaking application for supplemental education benefit awards--which is a small part of VA's total education applications. This program consists of more than 1,100 lines of code covering about 420 decision points. One Navy automated disposal application--also a relatively minor program compared to others--contains about 7,300 lines of code with more than 290 decision points. More complex software, such as the Navy cyclical repair management program, has more than 64,800 lines of code with at least 630 decision points.

The sheer detail and complexity of the process can cause design and programing errors and omissions which are not caught in review and testing. Therefore, bad decisions occur.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Reliance on the expertise and experience of people doing the work

The nature of the design process causes agencies to rely on designers who must be experienced in both the software design and the function to be supported by these applications.

Federal designers are

--schooled in the art of software design and learn the function to be supported,

--experienced in an operating function and learn the art of software design, or

--former programers and are promoted to the design function. Programers are generally schooled in writing code in specific computer languages.

Much reliance is placed on the individual designer's ability to convert user requirements to the type of detailed logic needed for programer coding. Reliance is also placed on the programer's ability to write code according to the logic given him. Because of the detail and complexity involved, it is difficult for management to review and assess every aspect of the designers' and programers' work.

Undetected changes in circumstances making the application obsolete

A cause for erroneous decisionmaking criteria includes the failure to identify and/or to relate changes in processing circumstances to the operation of the application. Once the application is operational, it will make decisions --good or bad--on the same basis until it is modified.

Not recognizing changed circumstances so that applications could be modified could result in bad decisions based on criteria that were correct when designed, but which no longer applied.

State of the art of program testing which prevents testing all possible conditions

The current state of the art makes it difficult for agencies to test for all conditions that may occur during the transaction processing. Most agencies cannot even be sure that the tests have exercised every line of code. As result, accepted software can contain design and/or

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

coding errors not identified during the test phase. Some of these errors may not be detected until long after the application becomes operational.

The inability to test for all conditions also precludes a full evaluation of user and designer criteria built into the program (if and when such evaluation is attempted.)

DATA PROBLEMS

Data used by the computer in making decisions comes from a variety of sources, both internal and external to the agency that has the computer. A tabulation of the various sources of data input for the 128 automated decisionmaking applications identified is presented below.

Source of input document	Number of applications in which the originator was cited
People within the agency operating the application	49
People located outside the agency operating the application but within the same Federal department or independent agency	23
People located in non-Government activities	12
People located in other Federal departments or independent agencies	7

Control over the completeness, accuracy, and currency of data largely depends on the source. Obviously, the correctness of an application operated at an agency where all the data comes from outside sources largely depends on the quality of data submitted. Some controls can be applied to incoming input, but they cannot guarantee completely error-free data.

According to some Federal officials, the largest single data problem is validating input data. However, data quality must be controlled from the moment data enters the system until the automatic processing is complete.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Types of controls for data

There are two basic types of controls for insuring the completeness, accuracy, and currency of data used by a computer in making decisions.

1. External controls are procedures developed outside the computer system. The objective is to check the quality of data to be put into and contained in the computer system. The controls include such things as manual procedures designed to determine if data is recorded completely and accurately on input documents and whether documents are being received and/or processed on time.

2. Internal controls generally do not involve human intervention. Many of these controls are built into the software. They include edit checks for completeness, logical relationship tests (does the data make sense?) and reasonableness checks (to isolate predetermined out-of-bounds conditions).

According to the National Archives and Records Service, General Services Administration (GSA), both types of controls are necessary and no automated decisionmaking application can be reliable if either type of control is deficient.

These applications use data originally prepared by people. The data input process often consists of people

--filling out hard copy documents, 1/ often on predesigned standard forms, and

--converting the data to a form that can be read by the computer--machine-readable form.

As part of the external controls that should exist, the people doing the work should be qualified and adequately trained. Adequate guidelines should be given to these people on a timely basis instructing them how to fill out the documents involved, including what entries should be made under varying circumstances. The forms (hard copy and input) should be designed to be as simple as possible

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1/Under some circumstances, such as source data automation and direct input devices, hard copy documents are not prepared.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

to allow for easy reading by people. Procedures should exist for reviewing (i.e., statistical sampling) input documents to test their completeness and accuracy. Controls should also provide for timely processing of the data.

If incomplete or inaccurate data enters the computer system undetected, automatic actions can be incorrect. The actions will continue to be incorrect if that data is stored in ADP files and reused. These applications can also make incorrect decisions if current data is not put into the system.

Causes of data problems

To identify some of the causes of the data problems, we

--contacted Federal officials at several agencies,

--received responses to questionnaires from 205 individuals who are experienced in the area of data management in computers, and

--analyzed causes cited by internal auditors.

A schedule summarizing some of the causes of data problems is followed by a discussion of each.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Summary of Causes of Data Problems

Cause	Opinions of people answering the questionnaire --degree of causes (note a) Moderate to very large	Somewhat small or none	Identified from contacts with officials of Federal agencies (note b)	Cited as a cause by internal auditors
Forms designed and used for input preparation are too complex.	183	21	x	
ADP files are not always adequately reviewed to assure that good data is being used.	178	26	x	x
Instructions to people preparing data input are not always provided, are provided late, or are not adequate.	175	30	x	x
Preparers of data input are not always adequately trained.	159	46	x	x
Manual reviews of input documents are not always adequate.	144	61	x	x
High volumes of transactions cause input preparers to make errors (workload pressures).	131	73	x	x

a/The questionnaire presented "some possible causes of the data conditions (problems) * * * " and asked that "based on your data management experience * * * indicate the degree to which you believe each of these causes contributes to the data condition (problems) in general." The responses allowed were to a: very large degree, somewhat large degree, moderate degree, somewhat small degree, or very small degree, or not at all.

b/Our contacts were made with various organizational elements, excluding internal audit, within six agencies: the Department of the Navy; Department of Health, Education, and Welfare; Veterans Administration; National Bureau of Standards; National Archives and Records Service; and Civil Service Commission.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

The errors occur at the source of data preparation. They are not detected by the various internal controls in the software because controls for the specific error (1) are not designed or (2) cannot be designed.

Forms designed and used for input preparation are too complex

Using simple forms to record, collect, transmit, and process information for input to computers improves the completeness and accuracy of the data eventually used by all computer application programs. The more complex the forms are, the more prone they are to data errors, which can affect the correctness of actions initiated by automated decisionmaking applications.

ADP files are not always adequately reviewed to assure that good data is being used

A recognized external control technique is to output and review data contained in ADP files. Failure to do this can result in obsolete or otherwise incorrect data used in automated decisionmaking applications. Incorrect decisions are therefore initiated. Without reviews, it is possible for some data errors to remain undetected for years and to allow for an accumulation of errors compounding the problem.

Instructions to people preparing data input are not always provided, are provided late, or are not adequate

It is important to provide clear instructions to people preparing input documents. Timely updating of these instructions when changes occur is also important. The failure to issue clear and timely instructions can cause data errors that may not be detected by internal controls.

Preparers of data input are not always adequately trained

Most training in the input data preparation area is done by individual agencies, because it must be geared toward the individual application, each with its own special forms, data content, and related input media.

Inadequate training of persons involved in processing data to the computer (such as filling out forms and punching cards) can lead to high error rates which result in bad decisions made by these applications.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Manual reviews of input documents are not always adequate

External controls include selective manual reviews of input documents to determine completeness and accuracy. These reviews, made by supervisors or quality control groups, should be geared toward measuring the quality of data entering the system, including determining trends, significance, and sources of errors.

When there are different types and sources of input, review procedures should cover them all. Developing and monitoring statistical error rates is important. The review procedure, however, should also include determining the errors' potential materiality so that management can make judgments on where corrective actions should be taken.

Manual reviews supplement internal controls by (1) disclosing needed software data validation (such as edit checks) that is missed because of software problems or (2) identifying trends of material data errors which are not detected by software data validation.

High volumes of transactions caused input preparers to make errors (workload pressures)

Automated decisionmaking applications are designed, in part, to help organizations cope with the high volumes of transactions that have to be processed. Although the computer processes the data once it is entered, the volumes of documents (hard copy and machine readable) that must be prepared are tremendous. For example, we estimated that during a 12-month period, the VA Center, Philadelphia, Pennsylvania, prepared more than 4 million documents for input to computers. Other VA activities throughout the United States also prepare such input documents. The Navy Aviation Supply Office (ASO), also in Philadelphia, annually receives about 10 million transaction reports for input to computers. The transaction reports are mainly prepared by Navy facilities that receive, store, and issue aeronautical equipment.

The volumes of data that must be processed by people recording material on original documents and preparing machine-readable documents can lead to workload pressures that result in data errors.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 5

FEDERAL MANAGEMENT OF AUTOMATED DECISIONMAKING APPLICATIONS

Although we believe that most decisions made by these applications are correct, we know from audit reports we reviewed that they also make bad decisions that cost the Government many millions of dollars annually. Additionally, bad decisions can impede agency mission achievement and may result in harm to people.

To a large degree software design and data quality control are an art. Much of the process is imperfect because people instruct the computer and supply data to it.

The fact that computers will act only as instructed by people, and on data prepared by people, makes them particularly susceptible to incorrect output, which in an automated decisionmaking application causes incorrect actions.

Undetected errors in preparing the software--whether caused by the user, the designer, or the programer--can cause the computer to repeat bad decisions. These errors will continue until the problem is detected and corrected.

Data problems may be random or repetitive. The repetitive problems resulting from such items as inadequate instructions and complexity of forms will also continue until corrective actions are taken.

RESPONSIBILITIES FOR ADP MANAGEMENT IN THE GOVERNMENT

Public Law 89-306, the Brooks Act, specifies the major ADP management responsibilities of the Office of Management and Budget (OMB), the General Services Administration (GSA), and the Department of Commerce.

Under this act, the Administrator of General Services is charged with economic and efficient purchase, lease, and maintenance of ADP equipment by Federal agencies. The Administrator also has some control over using ADP equipment. The Department of Commerce is authorized to provide scientific and technological services for ADP systems and to make recommendations concerning ADP standards. This is carried out through the National Bureau of Standards' Institute for Computer Sciences and Technology. The act states that the authority granted to the Administrator of General Services and to the Secretary of Commerce is subject to

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

policy and fiscal control by OMB. This constitutes oversight responsibility for the area.

In response to Government needs for training and education in ADP, the Civil Service Commission's Bureau of Training operates an ADP Management Training Center. This center offers a variety of courses to Federal civil and military personnel. Certain portions of their curriculum address the controls area in automated systems. The material presented should assist in alerting managers who take these courses to possible control weaknesses in their agency's operations.

No Federal-wide guidelines on automated decisionmaking applications

Neither GSA nor the Secretary of Commerce has considered these applications as a separate subject matter for management consideration. There are, therefore, no established Federal guidelines for identifying, developing, operating, or monitoring these applications to insure that they are operating effectively and economically.

POLICY ACTIONS BY FEDERAL AGENCIES TO MANAGE AUTOMATED DECISIONMAKING APPLICATIONS

No Federal agencies we contacted had considered these applications separately from other types of computer application programs in issuing management instructions. When instructions on software design had been issued, they were general and dealt with such things as

--levels of approval required to initiate and process a design project;

--concepts of project management--including setting priorities, establishing target dates, and requiring cost-benefit studies;

--the phases of software design and the documentation required; and

--testing and certification requirements.

Considering the current state of the art and the human problems that exist, we agree with those Federal officials who contend that issuing detailed instructions on how to design these applications (or other computer application programs) will not in itself materially reduce many of the errors that are made in them.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Inventories of automated decisionmaking applications

Agencies have done little to establish centralized information on computer application programs that identifies these applications and shows their characteristics. Characteristics include the (1) nature of actions initiated, (2) monetary and other impact on operations, and (3) nature and sources of input. Information is sometimes available within an agency but must be pulled together from different sources. This is done mainly when requested by higher level sources, such as headquarters, a budget committee, or an agency such as GAO. It is not normally done.

WHAT AGENCIES DO

We studied what Federal agencies do in designing, modifying, testing, and operating these applications. We also studied how these agencies manage data entered and contained in their computers. The studies were made at selected agencies of the Department of Defense (Navy), HEW (Social Security Administration), and VA (education and insurance applications). We also visited a responsible headquarters agency in the Department of the Air Force to discuss these subjects on a limited basis.

We examined policy and existing procedures and practices for managing computer application programs but did not verify that they were being employed as described to us.

Despite the apparent variances in the nature and types of policies and instructions issued, the same types of problems exist at these and other agencies.

Design and modification

VA had no written instructions for designing or modifying computer application programs. VA told us that it relied on written text material as a guide. VA has issued instructions on establishing and controlling software design projects, establishing approval levels, and establishing priorities and target dates.

The Social Security Administration (SSA) has issued a guide that describes the various phases of the design and modification processes, establishes review and approval steps, and describes who is responsible for doing the work.

Neither agency has issued instructions on how to do the design work or what to consider when doing such work. VA officials do not believe that it is necessary or even

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

feasible to issue such instructions. SSA assumes that designers and programers are adequately trained and experienced since courses are continually offered so that skills can be maintained at a satisfactory level.

The Navy Fleet Material Support Office (FMSO) is the central design activity for Naval Supply Systems Command activities. They have issued instructions to designers and programers in the form of information processing standards. The instructions provide guidance on what designers and programers are supposed to consider when doing the work, including

--customer and mandated requirements;

--logical sequencing of ADP actions;

--types of input and output;

--data formats and uses;

--data accuracy, completeness, and currency requirements;

--error and exception conditions (edit checks); and

--data volumes and frequencies.

Independent reviews of designed and modified product

The reviews of the detailed designed product 1/ are generally made by the user and/or the people doing the work. According to agency officials the extent of these reviews varies from

--a page-by-page analysis made by ASO of products designed by FMSO to

--a less formalized cursory review made by supervisors or management.

1/Usually consisting of a narrative or flow-chart description of the processing to be followed by the computer during operation.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

We observed no requirements for making independent reviews of the detailed designed product. Essentially, the people doing the work are responsible for doing the detailed reviews.

The Air Force Audit Agency independently reviews selected data processing systems before they are implemented (preimplementation reviews). These reviews, made at four Air Force design activities, include evaluating the designed computer application programs and related edit checks.

This approach requires the auditor to become familiar with functions supported by applications, as well as learning basic software design and data control concepts. It includes reviewing and evaluating (1) the decisionmaking criteria, (2) the program coding, (3) the edit checks, and (4) other potential data problems.

The Audit Agency had never calculated the cost savings that resulted from identifying and correcting potential problems before the applications were placed into operation. A major reason cited was that since corrective actions were often taken on the spot, there was no need for estimating unnecessary costs that would otherwise have resulted during operation.

Preimplementation audit reports of the Air Force Audit Agency showed that many of the problems that had been reported in operational automated decisionmaking applications were identified during preimplementation reviews, and Air Force design officials agreed that the problems existed. For instance, reports showed examples of

--erroneous decisionmaking criteria

--programing errors, and

--inadequate data controls.

We discussed the concept of independent preimplementation reviews with the Deputy Director of the Air Force Office of Data Automation. He agreed with the concept of such independent reviews but preferred that the reviews be made by independent teams within the design activity. He believes that auditors should become involved in evaluating designed or modified applications as soon as possible after the applications are placed into operation.

Despite not making a savings analysis on preimplementation changes, the Air Force Audit Agency believes that preimplementation reviews should continue because:

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--The quality of data systems is improved as a result of Air Force Audit Agency reviews.

--The dollar impact of resources managed by many automated systems is a proper subject for special audit.

--Systems audits during the development stage help increase the auditor's knowledge of the systems.

--The ability to make effective and efficient follow-on audits of operations is enhanced by the preimplementation reviews.

Testing

After the designed or modified application program is coded, agencies test the logic to determine whether the program will run and will perform the processing desired by the user. A description of the nature of testing by each agency follows.

--Programers at the Navy FMSO prepare predetermined test cases and files to test the logic of the program. If the results are satisfactory, the user operates the program with a duplicate ADP file and a selected number of actual transactions, which varies with each application. Some of the selected transactions are traced to determine if the program is operating as intended and whether the decisions being made are the same as operating personnel would make under the circumstances. The user advises FMSO if there is a problem.

--Programers and designers at SSA test both test cases and actual transactions. The number of selected transactions will vary depending on the complexity of the program. The user is required to certify that the program is operating according to the user's requirements.

--VA primary testing is done by independent system auditors assigned to the Department of Data Management. The system auditors are independent of the programers and designers, although they also work for the same department. The system auditors use a large number of test cases that have been developed and reused during the years. An automated comparison of the processing is made before and after the logic changes, and the differences are printed out. Unless there are many differences, all are reviewed for correctness. The cases that are not printed are not

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

reviewed. The auditors must certify that the logic conforms to the user requirements or issue exception reports when it does not.

Federal officials recognize that the current state of the art in program testing is imperfect. According to Officials of the Institute for Computer Sciences and Technology of the National Bureau of Standards, most test procedures currently used do not insure that all lines of codes have been exercised. Officials at the agencies visited agree that it is virtually impossible to test for every condition, but say they do the best they can by

--testing as many conditions as considered feasible and necessary and

--adding to test case material conditions which caused problems during operations but had not been identified during the original test phase.

The Institute and the Air Force consider the test phase an area where the current state of the art must be advanced.

The Institute was aware of numerous examples of computer application programs which were considered to be adequately tested but which, during operation, ran into serious problems and caused incorrect actions. As a result, the Institute in cooperation with the National Science Foundation worked on methods to improve the state of the art.

One recently developed procedure is a software program that will monitor tests of computer application programs written in FORTRAN (a programing language). This program counts the number of times each line of code has been exercised by test cases. Even though there is no insurance that every conceivable condition will be tested, there is insurance that each line of code has been tested at least once. Until recently, this capability was not generally available.

In a February 1972 report, the Air Force said that software design and testing were the two most critical problems in ADP requiring further research and development. In July 1973 the Air Force entered into a contract for the development of the type of software device that the Institute had developed out for a different programing language.

Monitoring of program operation

VA and the Navy largely rely on (1) internal auditor's reviews and (2) feedback from people affected by bad

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

decisions or operating personnel to identify automated decisionmaking application problems. No formal systematic monitoring of the applications' output is made, with one exception; VA audits education payments to veterans in excess of a predetermined amount. We believe that this is of limited value in identifying many costly systematic problems in automated decisionmaking applications because some types of transactions will never be reviewed.

SSA has a formal monitoring group continuously taking random samples of automated decisionmaking application output. According to SSA officials, this sampling has identified design and programing errors and repetitive data errors causing erroneous payments in operating automated decisionmaking applications. Examples of the kind of errors identified by this monitoring function include:

--Design, coding, or data problems in the automatic computation or recomputation of initial or subsequent benefits.

--Data problems in processing notices which affect payments.

--Design or coding problems in the updating of master data records (ADP files).

--Inadequate preparation of data.

SSA told us that system design and coding errors, as well as systematic repetitive data errors, were corrected as a result of this procedure. However, it could not give us statistics on numbers of errors found or their potential monetary impact, because SSA did not have this kind of information. 1/

SSA requires categorizing, in addition to monitoring, the reasons for required program modifications. The categories include:

--Incomplete or incorrect performance requirements or program specifications.

--Logic errors or program omissions.

1/Monitoring procedures are not always carried out as soon as new programs are placed into operation. The supplemental security income program, an automated decisionmaking application, did not have full-scale monitoring during its initial operational periods.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--Incomplete validation of input data.

--System-produced data not in accordance with specifications.

--Incomplete testing.

HEW headquarters said that a consulting firm noted a need for continuing reviews and evaluations of, among other things, applications software. The firm suggested that a four-member team, including an auditor, be responsible for reviewing selected applications on a short-term cyclic basis including (1) reviewing the application against the original specification to determine that the software was performing as intended and (2) determining whether application programs had been adequately modified when the processing circumstances changed. HEW did not accept the firm's report

Data control

The sources of data input vary for the following locations.

--Navy ASO, Philadelphia, receives much of its data from external sources including (1) contractors for new aeronautical equipment entering the supply system and (2) other Navy activities that receive, store, and issue aeronautical equipment.

--SSA, Baltimore, Maryland, receives most of its data from about 1,300 offices and centers throughout the United States.

--The VA data processing centers in Hines, Illinois, and Philadelphia, receive data from several VA stations throughout the country.

Internal controls

Our review shows that, even though written procedures may not exist, agencies develop and program extensive edit checks in software to help insure the validity of data coming into the system. Agency officials admit that, although extensive work is done to analyze potential data errors during the design process, edit checks cannot be designed to identify all types of data errors.

In many cases erroneous but acceptable data may be placed on input documents. Because such data can represent a valid situation, there may be no way to design an edit check to insure that it is correct. Also, edit checks will

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

not catch errors not conceived of--and therefore not considered--in designing edits.

Agency officials agreed that, because of the detail and complexity involved in the design process, potential edit checks may be missed.

Examples of the types of checks observed at the three agencies visited included

--edit checks for incomplete data elements;

--reasonableness checks; for example, rejected documents containing numerical values above or below a predetermined amount in a given data element;

--logical checks; for example, checks for impossible conditions, such as negative inventory balances or alphabetic characters contained in data elements that were designed to contain only numeric characters; and

--data relationship checks; for example, comparing data elements with other data on the same input document and/or contained in ADP files.

External controls

Because agencies receive input from numerous sources, we limited our study of external controls to the controls at the agencies actually visited (VA Center, ASO, and SSA).

--VA has written procedures for several external control functions which include (1) random sampling of input documents to identify and develop statistics which are used for identifying error rates and error sources, (2) selected verification of eligibility data contained in ADP files, (3) date stamping and sampling of documents to control the timeliness of documents processed, and (4) controls over unprocessed (pending) documents.

--ASO makes no manual reviews of supply-related data received from Navy activities and therefore primarily relies on (1) controls at the data preparing site and (2) internal controls designed in the ASO software. ASO makes selected manual reviews of data received from contractors on new aeronautical components before the data is allowed to enter the system.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--SSA basically relies on the (1) internal controls designed into the software, (2) end-of-line monitoring procedures, and (3) manual reviews at the vast numbers of offices and centers preparing the data.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 6

AUTOMATED DECISIONMAKING APPLICATIONS CONTINUE TO MAKE BAD DECISIONS UNTIL PROBLEMS ARE CORRECTED

Errors made by users, designers, and programers of automated decisionmaking applications, if not identified and corrected in the review and testing phases of the design process, can cause bad decisions which will continue until the errors are detected and corrected. When an insignificant error for a given action is multiplied by thousands or millions of the same type of actions over a period of time, the error is compounded. Unnecessary costs will grow and become large. An error allowed to exist for 5 years will cost the Government more than if the error is detected and corrected within, for example, 3 months after the automated decisionmaking application is in operation.

ERROR DETECTION

In previous chapters we discussed what agencies do to detect design and data problems. Because errors get through design and test processes and because data errors are made, early detection of them is important in reducing the cumulative effects of bad decisions.

ERROR CORRECTION

Detecting errors occurring in automated decisionmaking application software and/or data will not, by itself, stop the unnecessary costs being incurred. When detected, action must be taken to correct the errors by modifying the software, or improving the data quality, or both.

We have noted some instances in which problems were identified but corrective actions were not taken for a long time. An example follows.

Navy use of overstated demands in automated decisionmaking applications

A GAO report, B-162152, May 21, 1974, noted that in [illegible] Navy auditors saw a need to design a routine in the standard computerized supply management system used by Navy inventory control points for removing from ADP files past material usage quantities (demands) associated with canceled requisitions. The demands recorded in these ADP files were used by several automated decisionmaking applications.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

The report noted that in 1969 Navy command officials agreed with the need to properly adjust demand forecasts for invalid orders but said that it would not be able to correct the problems before 1971 because of other priority work. The report said that, at the time of the GAO review in 1972, the Navy was still not eliminating from ADP files demands related to invalid orders.

We estimated that about $34 million in invalid demands were in Navy ADP files and that these overstated demands resulted in unnecessary materiel buys and repairs totaling about $10 million a year. At least $3 million in annual unnecessary costs were initiated by automated decisionmaking applications using this overstated demand data.

The design change to correct the condition had not been made at the time of this review, so we discussed the reasons for the delay with appropriate Navy officials.

We were told that, because of the GAO report and direction received from the Department of Defense, a high-priority project was established on June 14, 1974, to make the needed design modification.

The reasons cited by Navy officials for the 5-year delay in initiating the modification included

--disagreements within the Navy on whether all canceled requisitions should result in reducing recorded demands,

--high-priority workload at the design activity mandated by higher headquarters levels in both the Navy and the Department of Defense, and

--lack of pressure placed on the Navy command and design activity by the inventory control points since reduced demands could result in budget reductions.

AGENCY PROCEDURES FOR TIMELY CORRECTION OF SOFTWARE DESIGN PROBLEMS

Agencies establish priorities and target dates for software design and modification projects. Agency guidelines also require cost-benefit studies to justify establishing and committing resources to a large design effort.

According to some Federal officials, however, little attention is given to doing cost-benefit studies which

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

demonstrate either (1) how much will be saved by eliminating an automated decisionmaking application problem that exists or (2) how much the continuing automatic decisions will cost the Government if the problem is allowed to go unchanged.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 7

OPINIONS ON WAYS TO PREVENT OR REDUCE THE IMPACT OF PROBLEMS IN AUTOMATED DECISIONMAKING APPLICATIONS

We believe that, despite the imperfect state of the art in application design and the widespread problems of getting quality data to the computer, every Federal agency using these applications should consider doing certain things to prevent or reduce the impact of the problems identified in this report.

We issued a questionnaire to 200 members of each of the following professional associations that are dedicated to furthering the quality of ADP-produced products:

--The Association for Computing Machinery's Special Interest Group for Business Data Processing.

--The Association for Computing Machinery's Special Interest Group for Management of Data.

--The Society for Management Information Systems.

The questionnaire described the various problems that we had observed in both the software design and data areas and requested the members to rate possible solutions presented in terms of their effectiveness and cost benefit. The ratings were designed to determine the validity of each solution, assuming each application involved spending millions of dollars or had an impact on people.

Some of the solutions can be applied before the application becomes operational to prevent problem conditions. Some of the solutions were to be applied after the automated decisionmaking application became operational to detect problem conditions early. If timely correction is made, the impact will be reduced.

A total of 263 people responded to the questionnaire.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Summary of People

Answering the GAO Questionnaire

Affiliation of data processing professional	Portion of questionnaire qualified to answer			
	Design and data	Design only	Data only	Total
Commercial concern	136	45	4	185
Academic	34	10	1	45
Government	25	1	1	27
Not indicated	4	2	0	6
Total	199	58	6	263

POSSIBLE SOLUTIONS--SOFTWARE PROBLEMS

Some of the highly rated solutions to the various design conditions are:

--Documentation should be prepared that highlights (1) key portions of the automated decisionmaking criteria, (2) data elements that are critical to the decisionmaking, and (3) the edit checks placed (or justifications for omitting them) in the software. A formalized synopsis of these items should be prepared for review and approval by top management.

--Qualified auditors or others who are independent of designers and users should review the designed application before it is placed into operation. Others could include a design team independent of the original designer and user. They would be responsible for evaluating the (1) adequacy of the decisionmaking criteria, (2) logic in the coded application, and (3) need and uses of edit checks to detect incomplete data elements put into the application.

--Similar independent teams should review the operation of these applications shortly after they are implemented. The objectives would be to evaluate the adequacy of the decisionmaking criteria in an operational environment and to provide for early detection of any bad decisions. This would allow for early correction of problems.

--Some form of cyclical system monitoring of actions initiated by operational automated decisionmaking applications should exist. Teams composed of (but not restricted to) designers, users, and auditors could

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

analyze application-initiated actions to (1) see if desired results were achieved the best way, (2) identify unforeseen circumstances that would require modifying the application, (3) determine that the actions were as the user and designer in ended, and (4) insure that decisionmaking was not adversely affected by incomplete data not being screened by an edit check.

--The designer and user should be physically located in the same place during design phases to allow for constant communication. In effect, the design would be a joint effort and would help to insure that adequate decisionmaking criteria were contained in the application.

--Priorities should be established for software modification (changes) which are at least partially based on the cost of continuing incorrect automatic actions if no changes are made within a short time.

--The initiator of the needed software modification (for example, headquarters, user, audit team, and/or others) should be informed about the status of the change and be provided with confirmation that the changes have been made.

POSSIBLE SOLUTIONS--DATA PROBLEMS

Some of the highly rated solutions to the various data conditions are to:

--Establish followup procedures for insuring the (1) timely receipt of data preparation instructions and (2) use of instructions by data preparers.

--Emphasize in training the importance of complete and correct data on computer input documents.

--Make selective manual verification of key data on input documents and in ADP files with hard copy documents and with the data originator.

--Establish a single organization (data base administrator) that could be responsible for the above steps as well as evaluating and testing internal and external data controls employed and input documents designed and used.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

CHAPTER 8

CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS

Automated decisionmaking applications initiate the spending of billions of dollars a year without anyone reviewing and evaluating the individual actions. They are also used to support a multitude of functions that, although not directly related to money expenditures, can affect mission achievement and make decisions regarding individuals.

Many of these applications make bad decisions because of various software and data problems. The causes of the problems are numerous. Bad decisions may result in unnecessary costs and overpayments of hundreds of millions of dollars a year--exactly how much is unknown. Such bad decisions can also impair mission performance and harm individuals.

In the current imperfect environment, the chances of continuing bad decisions and unnecessary costs are great. Actions are needed. We believe that it is necessary therefore to develop and issue Federal-wide guidelines to foster uniform cost-effective practices that will (1) minimize the chances of problems occurring, (2) detect as soon as possible the problems that do occur in operating automated decisionmaking applications, (3) correct problems as early as possible to reduce their adverse impact, and (4) insure that the practices are being effectively applied.

Some practices we consider necessary to meet these objectives already exist at some agencies. For instance, we observed testing, joint design, and inclusion of internal data controls. We also observed some established data management practices which could identify data input problems.

Several practices considered by us and by data processing professionals to be cost effective in reducing the chances or impact of bad decisions were not being applied to all crucial automated decisionmaking applications. This indicates a need for central guidelines in such areas as:

--Preparing documentation and/or a formalized synopsis that highlights, for example, key decisionmaking criteria, data elements critical to the decisionmaking, and edit check placement to facilitate thorough reviews by others.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

--Making preimplementation reviews of the designed or modified applications and internal data controls. The reviews should be made by groups that are independent of the designer or user. The groups should consider evaluating, among other things, the (1) adequacy of the decisionmaking criteria, (2) logic in the coded application, and (3) needs and uses of edit checks contained in these applications.

--Analyzing actions initiated by these applications as soon as possible after they are placed into operation to insure that (1) they are operating as intended, (2) the intended operation is the most economical and effective method, and (3) circumstances that were not considered during design have not arisen.

--Cyclical or ongoing monitoring of automated decisionmaking application output to insure that (1) desired results are achieved most economically and effectively, (2) new circumstances have not arisen that will require changes to the decisionmaking or other processing criteria, (3) the logic is correct, and (4) decisionmaking is not adversely affected by incomplete data not being caught by an internal edit check.

--Establishing priorities and target dates for software modification which are at least partially based on the unnecessary costs of continuing incorrect automatic actions and keeping the initiator of modifications informed of the status of the changes.

--Establishing a single point in each organization that would have prime responsibility for insuring that these applications are making decisions based on the best data available by (1) evaluating and testing the data and data controls (internal and external), (2) adequately training data preparers, (3) reviewing the adequacy and currency of instructions given data preparers and insuring they are complied with, and (4) insuring that forms designed for data processing minimize the chances of data errors.

To begin focusing on what should be managed, top management in each agency should be aware of the automated decisionmaking applications that exist (operational and under development), the functions they support, their monetary and other impacts, nature and sources of input, the output-initiated actions, the programed reasons for any manual intervention, and other important characteristics.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Agencies should be required to take stock of their automated decisionmaking applications. This action should include ascertaining whether their current practices for developing, modifying, and operating such applications, together with related data controls, are adequate to surface problems of the types discussed. Guidelines should be issued to indicate cost-effective corrective procedures, and agency management should insure that automated decisionmaking applications are under control.

RECOMMENDATIONS

We believe that, since automated decisionmaking applications have not previously been recognized as a separate problem area requiring management attention and since millions of dollars are presently being wasted as the result of actions generated by such systems, the Office of Management and Budget (OMB) should act immediately to improve the situation. Specifically, we recommend that OMB, in its oversight capacity, require that:

--Each agency determine whether any of its computer operations involve automated decisionmaking applications.

--The agencies review each operation to determine whether incorrect actions are being taken as a result of these applications. (Pending issuance of technical guidelines by the National Bureau of Standards for making such reviews, the agencies should examine enough automatically generated decisions to provide a basis for deciding whether incorrect decisions are occurring and, if so, should take the necessary steps to correct the situation causing the incorrect decisions.)

--Before any new automated decisionmaking applications are initiated by an agency, the proper steps are taken to insure correct decisions. This would include, pending issuance of the National Bureau of Standards guidelines, a carefully chosen combination of independent review of systems design, adequate testing before implementation, and periodic testing of decisions after implementation, as discussed earlier in this report.

--Agencies report on the actions taken and establish an appropriate mechanism for monitoring such reports.

We recommend that, because the National Bureau of Standards has responsibilities for technical aspects by ADP, the

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Secretary of Commerce direct the Bureau to issue technical guidelines for developing, using, technically evaluating, documenting, and modifying these applications in the Federal Government. When issued, these guidelines should contain certain criteria for independent technical reviews and for monitoring of these applications to insure problems are detected and corrected promptly. The General Services Administration should incorporate Bureau guidelines in its agency directives.

In addition, we recommend that:

--As GSA suggested, the Civil Service Commission develop and add to its ADP training curriculum courses in automated decisionmaking applications so that managers, technical personnel, and auditors will become better equipped to deal with them in an appropriate manner.

--Internal audit groups in agencies having automated decisionmaking applications participate actively in design, test, and reviews of such systems to carry out their responsibilities.

Finally, we suggest that the Joint Financial Management Improvement Program consider this area for ongoing attention.

We are sending copies of this report to all departments and independent agencies for their information, use, and guidance pending issuance of the OMB and National Bureau of Standards material.

AGENCY COMMENTS

We issued the proposed report to several agencies for comment. Their replies indicate general agreement as to the problems reported and varying opinions on the recommendations.

With respect to the problems, the Associate Deputy Administrator, VA, agreed that there was a need for sound management of current large sophisticated data processing systems. He said the report was useful in identifying and consolidating the problems associated with automated decisionmaking applications. He believes that the formulation of standards relating to these applications is imperative.

The Assistant Secretary, Comptroller, HEW, said that no one would disagree that software and data problems exist and that such problems could result in automated decisionmaking applications that made erroneous decisions in some

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

cases. He believed that as much emphasis should be placed in preventing software errors as in detecting and correcting them. He agreed that the current state of the art in software development could not assure error-free software.

The Assistant Secretary of Defense, Comptroller, said that most of DOD's automated systems fit the definition of automated decisionmaking applications, although damage resulting from errors in some systems was less direct and less measurable than in disbursing and supply systems. He added that our statements of possible solutions to software and data problems are logical and constructive and that while they are similar to many DOD practices, their documentation will assist system developers, auditors, and operators.

The Acting Administrator, GSA, said that the report performed a valuable service in identifying automated decisionmaking applications as an area of data processing concern and, as such, warrants wide circulation to ADP software managers in the Federal Government. He strongly agrees with our solutions for software and data problems, including

--preimplementation and postimplementation system reviews by independent groups and

--cyclical system monitoring.

The agencies had varying opinions on the tentative proposals contained in our proposed report. We have weighed their comments and considered them in formulating the proposals in this report. For example, we proposed that the agencies involved report to GSA on actions taken in response to our recommendations. Upon consideration of the responses to our proposed report, we have modified our recommendation to provide for OMB to determine an appropriate reporting mechanism.

Also in response to our proposed report, the Acting Administrator, GSA, suggested that the National Bureau of Standards could develop Government-wide guidelines for information systems development which could specifically include automated decisionmaking.

On January 12, 1976, we discussed the suggestion with the Director, Institute for Computer Sciences and Technology, National Bureau of Standards, who agreed to the need for Government-wide technical guidelines that would include developing, using, modifying, reviewing, and monitoring automated decisionmaking applications and said that budgetary resources would be solicited for the National Bureau of Standards to perform this task. The guidelines, when

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

completed, would be issued as part of the Federal information processing standards series for use by Federal agencies.

We informally discussed the recommendations with OMB officials who have responsibilities in the ADP area. They believe that the report points out important problems in this area and agree that issuing policy guidance is appropriate.

We discussed our recommendations to the Civil Service Commission with officials of the ADP Management Training Center who agreed to further emphasize controls in their ADP training.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX I

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

NOV 17 1975

Mr. Gregory J. Ahart
Director, Manpower and
Welfare Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

The Secretary asked that I respond to your request for our comments on your draft report to the Congress entitled, "Improvements Needed in Managing Computer-Based Automated Decisionmaking Applications in the Federal Government." They are enclosed.

We appreciate the opportunity to comment on this draft report before its publication.

Sincerely yours,

John D. Young
Assistant Secretary, Comptroller

Enclosure

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

COMMENTS ON GAO'S DRAFT REPORT ENTITLED "IMPROVEMENT NEEDED IN MANAGING COMPUTER-BASED AUTOMATED DECISION MAKING APPLICATIONS IN THE FEDERAL GOVERNMENT"

OVERVIEW

The draft report identifies a certain type of EDP application which GAO calls an Automated Decision Making Application, (ADMA), and notes that ADMAs are widely used by Federal agencies. The report points out that the distinguishing characteristic of ADMAs, as compared to other computer application programs, is that many of the actions initiated by the computer take place without review and evaluation by people. According to GAO, there are indications that funds are being wasted because of incorrect, unreviewed actions.

The report discusses, at some length, the use of ADMAs by Federal agencies, and points out that ADMAs can make bad decisions. It categorizes the causes of these bad decisions as being software problems or data problems, then goes on to identify and discuss the reasons for these problems.

No one will disagree that software and data problems do exist, and that such problems can result in ADMAs that make erroneous decisions in some cases. It is of utmost importance, therefore, that such problems be prevented during the design and implementation of the system. While we are of the opinion that the current state of the art in software development techniques and test techniques cannot assure that error free software can be designed, techniques are available that can contribute significantly to the reduction of software errors. Furthermore, practice has suggested that the method of organization of a development effort can have a favorable impact on the error level as well as the development cost.

Since the state of the art of development and testing techniques cannot assure error-free software, it is of equal importance that reviews of systems take place before operation, shortly after implementation, and on continuing or cyclical basis for operational systems. The extent of review of an ADMA should be a function of the probability and impact of errors.

The report discusses various ways to prevent or reduce the impact of problem conditions in ADMAs. In our opinion, the possible solutions mentioned in the report are, for the most part, reasonable. We would, however, place a greater emphasis than made in the GAO report on (1) involvement of the user in the development of an ADMA and (2) approaches to reducing probability of errors at the design and test stages rather than emphasizing error detection and correction in the operational stage.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

GAO concludes that the development and use of ADMAs is necessary but because of the current imperfect environment, chances of continuing bad decisions and unnecessary costs are great. Consequently, GAO believes that it is necessary to develop Federal-wide policy to foster uniform cost-effective practices that will minimize the chances of problems occurring, detect the problems as early as possible, and assure that the practices are being effectively applied.

GAO RECOMMENDATIONS AND HEW COMMENTS

RECOMMENDATIONS

Because GSA is responsible for developing Government-wide policy on ADP management and for seeing that the policy is carried out by the departments and agencies, GAO recommends that the Administrator, GSA:

-- Require the identification and characterization of ADMAs used by Federal agencies. (A starting point for material to be included can be the types of data GAO obtained during its study of ADMAs -- volume of transactions, impact of decisions, etc.). This will provide agency management and auditors with basic information on where their resources could best be applied.

-- Issue policy requirements and guidelines for the management of ADMAs in the Federal government. Most importantly, the policy and guidelines should establish criteria for independent reviews and monitoring of ADMAs to assure that problems are detected and corrected in a timely manner. The policy should also include criteria for cost-effective development, modification, documentation, review and testing of ADMAs.

-- Require agency reporting concerning (1) actions taken based on the criteria and (2) problems identified and corrected as a result of independent reviews and monitoring of ADMAs. Justification of cost effective ways of managing ADMAs should be included.

HEW COMMENTS

With respect to GAO's first recommendation, we do not believe that it would be useful to have all agencies identify and characterize their ADMAs. To do so would result in the preparation of an enormous volume of reports covering hundreds of ADMAs. Since it is unlikely that GSA would be

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

able to effectively utilize these reports, their development and preparation would be a waste of agency time and resources. For similar reasons we do not favor GAO's third recommendation which would require agencies to submit reports concerning the actions taken pursuant to GSA policy directives.

We agree in principle with the second recommendation -- that GSA establish guidelines for the management of ADMAs in the Federal Government. The establishment of guidelines would encourage agencies to utilize acceptable practices for developing, modifying, reviewing and monitoring their ADMA systems.

We are of the opinion that such guidelines as GSA might develop must be flexible to recognize that ADMA systems are of varying complexity and of varying impact in terms of probability and cost of errors. Thus, practices employed for the development, modification, review, and monitoring of a particular ADMA should be oriented, towards overall cost reduction, i.e., expected cost of errors plus cost of development, modification,... In light of the diversity of ADMAs, we do not believe that it is practical to establish "policy requirements" at this time. We believe that a more effective procedure would be for GSA to issue guidelines and then to periodically conduct on-site reviews and audits of various agency ADMAs. The objective of such review would be twofold: (1) determination of the extent to which guidelines were being followed by agencies and (2) determination of the effectiveness and efficiency of the recommended practices so that they could be developed and refined based on actual experience.

Furthermore, as we indicate in the Overview to these comments, we believe that efforts to eliminate errors during development is of equal importance to the review and monitoring efforts. Therefore, we suggest modifying the second recommendation to read:

"Issue guidelines for the management of ADMAs in the Federal Government. These guidelines should include recommended practices and criteria for cost effective:

1. development, modification and testing of ADMAs to reduce error levels in software and data collection,

2. documentation of ADMAs for internal and external uses,

3. review and monitoring of ADMAs both as continuing activities by systems and user personnel and by independent groups."

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX I

OTHER COMMENTS AND SUGGESTIONS ON THE REPORT

1. In the third paragraph on page 58 of the draft report, a statement is made that "an SSA official said that they assume that designers and programmers are adequately trained and experienced and that such instructions are not necessary." This is not an accurate statement. We suggest that GAO change the sentence to read:

> "An SSA staff member said that designers and programmers are adequately trained and experienced since there are continuing courses offered in systems design so that skills can be maintained at a satisfactory level."

2. In the last paragraph on page 65, the second sentence reads "According to SSA officials, this sampling has identified many design and programming errors and repetitive data errors causing erroneous payments in operating ADMAs." The word "many" is misleading in that this is an end of the line operation and most errors are discovered in validations, etc. long before these operations are performed. The sentence should read:

> "According to SSA staff members, this sampling has identified design and programming errors and repetitive data errors causing erroneous payments in operating ADMAs."

3. The first paragraph on page 66 begins "SSA advised us that many system design and coding errors, as well as systematic repetitive data errors, are corrected as a result of this procedure." For the same reasons given in the preceding paragraph of our comments, the word "many" is misleading and should be deleted.

[See GAO note, p. 61.]

5. There is considerable overlap and duplication in several chapters of the report. In particular, we suggest that Chapters 3 and 4 be combined to improve readability.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX I

6. We believe, in general, that the report tends to underplay the importance of the user in the development of an ADMA. We note with interest that in the opinion of "people answering the questionnaire" (page 36 of the report) the most often cited problem is "inadequate communications between the parties to software design." The second ranked problem in this list is "incorrect perceptions of the nature of the actual transactions to be processed."

Furthermore, in Chapter 7, "Opinions on ways to prevent or reduce the impact of problem conditions in ADMAs," respondents from several professional organizations suggest that "Physical collocation of the designer and user should be accomplished during the design phases to facilitate constant communication. In effect, the design would be a joint effort and would help to insure adequate decision-making criteria contained in the ADMA." Despite the importance of these causes of errors and of this recommendation of professionals to overcome them, the policies advocated by GAO in Chapter 8 fail to address the necessity of user involvement.

Therefore, we suggest that the GAO report place greater emphasis on the participation and responsibility of the user in an ADMA system. In commenting on the draft GAO report "GAO Guidelines for Management Information Processing Systems," May 1974, HEW stated: "The Guidelines include the user in the system development from the standpoint of user education as opposed to user participation. While user education is important, it is not enough. The success or failure of a system is critically dependent on user involvement and participation." We believe that this dependency is even more critical in an ADMA system.

7. The importance of personnel selection and training for ADMA development, operation, monitoring and review should be given greater emphasis in the GAO report. Designers and programmers should be familiar with design tools and techniques, e.g., structured and modular flowcharting and programming, decision tables, data base design tools, data element management, data collection alternatives. Management should be aware of alternative organizations for system development, e.g., chief programmer teams. Designers should also be aware of techniques for testing and monitoring systems including statistical sampling approaches. Knowledge can be obtained via government or private sector training courses.

GAO note: Material no longer related to report has been deleted.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

VETERANS ADMINISTRATION
OFFICE OF THE ADMINISTRATOR OF VETERANS AFFAIRS
WASHINGTON, D.C. 20420
NOVEMBER 28 1975

Mr. Gregory J. Ahart
Director
Manpower and Welfare Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

We appreciate the opportunity to review and comment on your draft report relating to the management of automated decision-making applications and are in agreement that there is a need for sound management of the large, sophisticated data processing systems in existence today.

[See GAO note.]

Your report has proved useful in identifying and consolidating, in one place, many of the problems associated with automated decision-making applications in a clear, straightforward language. We believe that the formulation of standards relating to these applications is imperative, and have already begun to draft our own general requirements and guidelines.

Sincerely yours,

Associate Deputy Administrator - in the absence of

RICHARD L. ROUDEBUSH
Administrator

GAO note: Deleted comments refer to material discussed in our draft report but not included in this final report.

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX III

UNITED STATES OF AMERICA
GENERAL SERVICES ADMINISTRATION
WASHINGTON, DC 20405

DEC 29 1975

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D. C. 20548

Dear Mr. Staats:

We appreciate the opportunity to review your draft report "Improvements Needed in Managing Computer-Based Automated Decisionmaking Applications in the Federal Government."

The report performs a valuable service in identifying automated decision-making applications (ADMAs) as a discrete area of data processing concern and, as such, warrants wide circulation to ADP software managers in the Federal Government.

We strongly agree with the following GAO recommended solutions for software and data problems:

- Pre-implementation and post-implementation system audits by independent groups.
- Cyclical system monitoring.
- Joint system design by users and ADP systems analysts.

In addition to the management solutions mentioned in the report, there are modern computer programming techniques which can aid in increasing the integrity of any system. Developing detail logic with decision tables rather than flow charts is particularly effective in data editing applications. The use of "top down" programming and "chief programmer teams" is proving successful in minimizing errors. Employment of a data base administrator throughout both the developmental and operational stages of a system will help assure that valid data is being processed.

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Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

While we generally agree with the conclusions and recommended solutions for software and data problems contained in the report, we do not agree with the recommendations that GSA issue policy and guidelines for the management of ADMAs nor that GSA require agency reporting to allow monitoring of agency performance. Rather we would suggest, since ADMAs are part of the broader universe of information systems development, that:

. The National Bureau of Standards, with GSA cooperation, develop government-wide guidelines relating to information systems development which should specifically include automated decisionmaking.

. Agencies report to their own agency head regarding decisionmaking criteria, ADMA problem identification and corrective actions taken, and that these reports be made available for review by OMB and GSA, in line with review provisions in Federal Management Circular 74-5.

. The Civil Service Commission include in its management training programs a course on automated decisionmaking stressing the need for cost effective development, joint systems design by users and ADP systems analysts, systems monitoring and auditing of ADMAs.

Because of the significance of this report, we had the opportunity to have the Ad Hoc Committee for Implementation of P. L. 89-306 briefed by a representative from GAO prior to issuance of this draft. This Committee is chaired by the Commissioner, ADTS, and representatives from ADP-intensive agencies are committee members. At a later meeting, our comments were discussed and the Committee generally concurred in the approach GSA is proposing.

If you have any questions, please let us know.

Sincerely,

Dwight Ink

Dwight A. Ink
Acting Administrator

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

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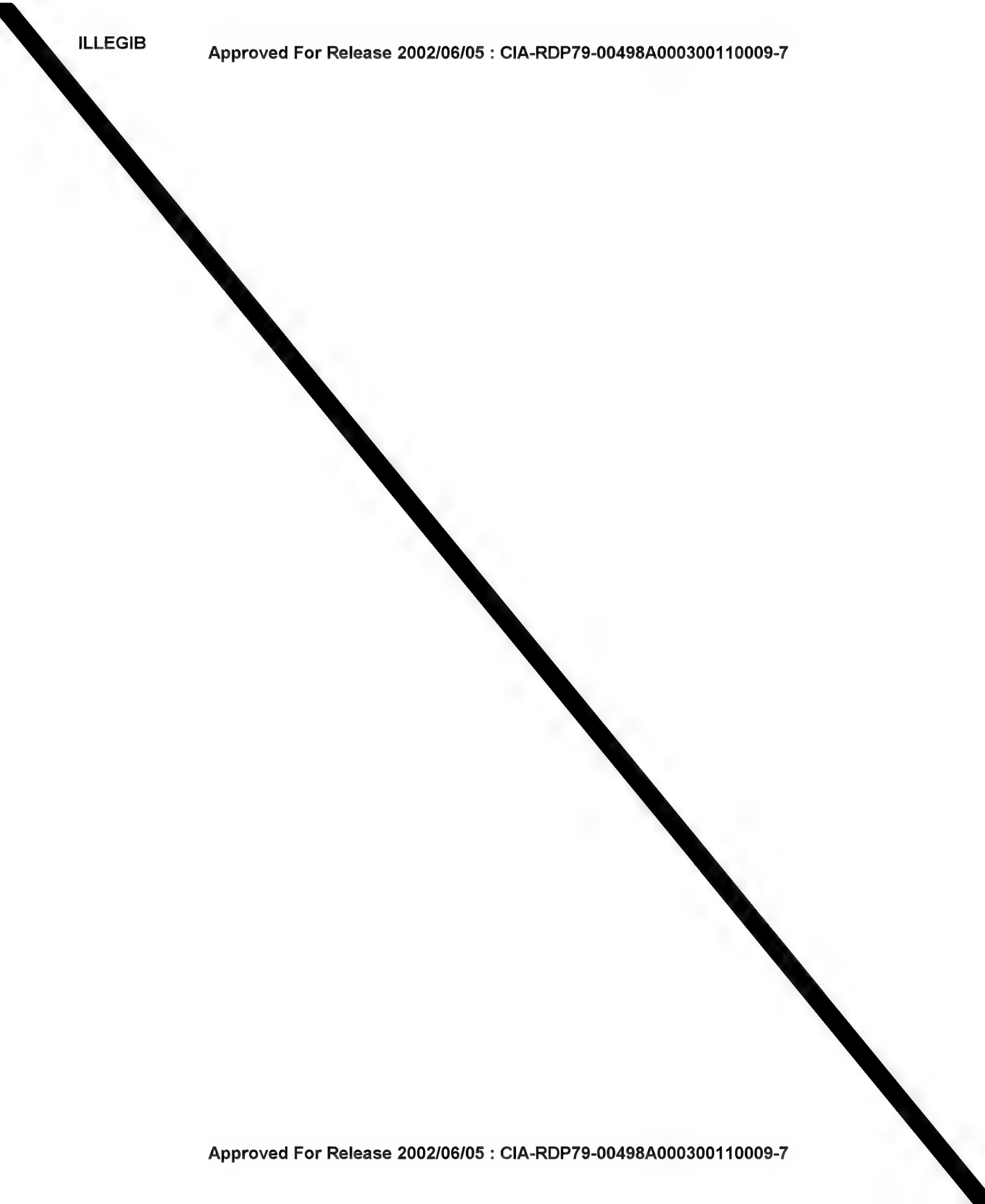

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Because of the unique problems of automated systems, we have and will continue to develop and apply special measures to their quality control. However, they are in no way exempt from standard Federal accounting system certification, management reviews, and internal audit controls. The net effect then is to increase management control of automated systems in comparison to manual systems.

Your statements of possible solutions to software and data problems are logical and constructive. While they are similar to many DoD practices, their documentation in a compact set will assist our system developers, auditors and operators.

With respect to the recommendations included in the draft report, we interpret GSA's charter in the ADP field to address procurement of ADP equipment, supplies and services. Your report is aimed at a different arena, that of functional procedures and accounting controls. Accordingly, we recommend that:

1. The subject be proposed as a matter of continuing interest by the Federal Financial Management Improvement Program. The inter-agency effort of senior financial managers is an appropriate forum for exchange of new procedures and techniques.

2. Pertinent and documented studies, research reports, methods and techniques be provided by developing agencies to the National Technical Information Service (NTIS) of the Department of Commerce for dissemination at cost to other potential users in accordance with the NTIS charter.

3. The report be issued as a study, retaining the findings and conclusions but deleting the recommendations and substituting the following:

> "Each Federal Agency should review its internal regulations and procedures for management of ADMA systems to assure protection of mission effectiveness and government resources from system errors. Each agency should establish specific internal procedures to assure that internal controls and audit trails for error detection and correction are made a part of system design specifications, tested prior to system implementation, and included in routine and special audits throughout their operational life."

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Thank you for an informative and valuable research effort. The opportunity to comment on the draft report is appreciated.

Sincerely,

Terence E McClary

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

INTERNAL AUDIT REPORTS ON AUTOMATED DECISIONMAKING APPLICATIONS

Title of report	Date	Type of application involved	Problem identified: Software	Problem identified: Data
Army Audit Agency:				
Coordinated Audits of Depots (Maintenance Operations)	3/ 4/74	Maintenance workload acceptance	X	X
U.S. Army Training Center, Infantry and Fort Polk	12/21/73	Requisitioning	X	
Direct Support System	10/16/73	Requisition processing	X	
Materiel Obligation Validation Procedures	2/ 8/74	Procurement cancellation	X	
Catalog Function	8/21/73	Automated procurement and requisition processing	X	X
Naval Audit Service:				
Servicewide Audit of the Aeronautical Reparable Components Program	12/ 6/73	Overhaul scheduling	X	X
Headquarters, Pacific Missile Range, Point Mugu, California	11/ 1/73	Requisitioning	X	
Navy Aviation Supply Office, Philadelphia, Pennsylvania	10/16/72	Redistribution	X	X

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX V

Title of report	Date	Type of application involved	Problem identified: Software	Problem identified: Data
Naval Audit Service (continued):				
Aviation Supply Office, Philadelphia, Pennsylvania	6/15/73	Requisition processing and redistribution	X	
Navy Aviation Supply Office, Philadelphia, Pennsylvania	12/10/74	Overhaul scheduling and redistribution		X
Auditor General, Defense Supply Agency:				
Physical Inventory Procedures and Practices	11/24/72	Physical inventory requests	X	
Medical Supply Functions	9/ 5/73	Customer returns, requisition processing and stock attrition	X	
Mobilization Reserve Requirements at Defense Supply Centers	5/18/73	Customer returns	X	
Veterans Administration, Fiscal Audit:				
Audit of On-Job and Apprenticeship Training Awards Processed by OCR	5/ 8/74	Payments	X	X
Processing Dependency Changes from Supplemental Award Code Sheets	9/17/73	Payments	X	

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Title of report	Date	Type of application involved	Problem identified: Software	Problem identified: Data
Veterans Administration, Fiscal Audit (continued):				
Processing Awards after Entitlement is Exhausted	8/ 2/73	Payments	X	
Nonrecovery of Accounts Receivable from Resumed BCL Account Payments	4/20/73	Payments	X	
Retroactive Payment Adjustments	8/31/73	Payments	X	
Updating Accounts Receivable Deduction Amount from Amended Awards	4/12/73	Payments	X	
Duplicate Chapter 34 Education Payments	8/ 2/74	Payments	X	
Interior, Office of Survey and Review, Audit Operations:				
Review of Contract No. N00C14205253 With the Navajo Tribe, Window Rock, Arizona, Bureau of Indian Affairs	10/29/73	Payments	X	
Agriculture, Office of Inspector General:				
Programs Option B Provisions of the 1972 Feed Grain Set-aside Program	10/25/73	Payments	X	

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX V

Title of report	Date	Type of application involved	Problem identified: Software	Problem identified: Data
Agriculture, Office of Inspector General (continued):				
Loading Order Issuance Processing and Settlement	8/ 8/73	Loading order settlement	X	X
Agriculture, Office of Audit:				
Automated Accounting Service	2/15/74	Payments and billings	X	X
HEW Audit Agency:				
Administrative Costs Incurred and Benefit Payments Made Under the Health Insurance for the Aged Act	1/ 9/74	Payments		X
Administrative Costs Incurred and Benefit Payments Made Under the Health Insurance for the Aged Program	12/28/73	Payments		X
Administrative Costs Proposed and Operations Relating to Benefit Payments Under Medicare	6/28/74	Payments	X	
Administrative Costs Claimed and Benefit Payments Made Under the Health insurance for the Aged Program	5/24/74	Payments		X

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7

APPENDIX V

Title of report	Date	Type of application involved	Problem identified: Software	Problem identified: Data
HEW Audit Agency (continued):				
Administrative Costs claimed and Supplementary Medical Insurance Benefit Payments Made Under Health Insurance for the Aged Program	11/ 9/73	Payments		X
Administrative Costs and Benefit Payments Under the Health Insurance for the Aged Program	11/12/73	Payments	X	X
Administrative Costs Claimed and Benefit Payments Made Under the Health Insurance for the Aged Program	5/ 1/73	Payments	X	X
Administrative Costs and Benefit Payments Made Under the Health Insurance for the Aged Act	4/12/74	Payments		X

Approved For Release 2002/06/05 : CIA-RDP79-00498A000300110009-7